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# **Monitoring Stress and Wellness in Elite Athletes Undertaking Tertiary Study**

A thesis  
submitted in partial fulfilment  
of the requirements for the Degree of  
**Master of Applied Science**  
At  
Lincoln University

**By**  
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**Lincoln University**  
**2018**

## **Monitoring Stress and Wellness in Elite Athletes Undertaking Tertiary Study**

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Athletes undertaking full-time sporting commitments alongside full-time tertiary studies (commonly known as sport scholars) are a unique population because of the need to perform to a high level in both sport and academic studies. For a sport scholar, academic workload creates significant stress which can add to the constant pressure to perform athletically. Sport scholars are forced to cope with issues such as missing class, extended travel, and added demands that non-athletes do not experience. Additional stressors include; time availability and management, social and organisational skills, and physiological and psychological developmental challenges. Students undertaking tertiary study are a vulnerable population to sleep difficulties, depression, anxiety, feelings of hopelessness, exhaustion, and a sense of being overwhelmed.

The aim of this study was to investigate subjective measures along with training measures to better understand the pressures sport scholars undergo, as well identifying times throughout the academic year where overall stress levels were counterproductive for an athlete's overall wellbeing. This study focused on 183 (132 male and 51 female) undergraduate sport scholars aged 18-25 years old at Lincoln University, Christchurch, New Zealand over a 4-year period, who were part of a scholarship programme. These participants were combining full-time tertiary study with full-time sport and training commitments. Athletes were required to enter their daily subjective well-being and training throughout the academic year as part of their scholarship programme. For this study, psychological measures of wellness such as academic pressure, energy levels, mood state, muscle readiness, sleep duration, and sleep quality, as well as training measures such as weekly training load and weekly training volume were used from the sport scholars' daily entries. The average completion rate for subjects entering their weekly subjective data was 34% in semester 1 and 21% in semester 2. Similarly, in semester 1 only 20% of subjects entered their weekly training data which reduced to 10% by semester 2.

All year levels demonstrated lower levels of wellness through subjective measures one week before exams, as well as during exams, before improving directly after exams and during breaks. Third-year sport scholars demonstrated the highest academic pressure, weekly training volume, and weekly training load, as well as the lowest energy levels, mood state, sleep duration, and sleep quality during the academic year. Mood state and sleep duration were substantially decreased for third-year sport scholars, with mood state being as low as  $3.1 \pm 1.21$  (mean  $\pm$  SD) on a 1-5 Likert-type scale during week 35 of the academic year, and sleep duration as low as  $6.8 \text{ hours} \pm 1.37$  during week 40 of the academic year. Female athletes demonstrated decreased levels of wellness compared to male athletes, including lower mood state ( $3.4 \pm 0.8$  /  $3.7 \pm 0.7$ ), energy levels ( $3.3 \pm 0.8$  /  $3.7 \pm 0.6$ ), and sleep quality ( $3.2 \pm 0.8$  /  $3.6 \pm 0.8$ ). Data are mean  $\pm$  SD for female and males respectively.

We found that mood state had the highest association with academic pressure ( $r = 0.30$ ), indicating a moderate association between how an athlete's mood state is and how they perceive their academic stress. Using a step-wise regression analysis to investigate what combination of subjective measures might have an influence on athlete's academic pressure, we found the combination of energy levels, mood state, muscle readiness, sleep quality and readiness to train was strongly associated with academic pressure ( $r = 0.66$ ).

This study found that there are certain times throughout the academic year where sport scholars are more vulnerable to stress, (e.g., during exams), as well as certain groups that require greater support (e.g., third-year athletes and female athletes). Maintaining an athlete's energy levels, mood state, muscle readiness, and sleep quality can help reduce their levels of academic pressure. These findings suggest the need for immediate interventions to be put in place to better support athletes stress leading up to exams, as well as the need to better support third-year athletes and female athletes to help them manage stress better, and to improve their wellness. In conclusion, we found that athletes undertaking full-time tertiary study alongside their full-time training commitments were vulnerable to increased levels of psychological stress. Implications of these findings are further considered.

**Key words:** *athlete monitoring, stress, wellbeing, wellness, sports, Lincoln University, psychology, physiology, prevention, fitness, health, intervention, mindfulness, university, athletes.*

## Acknowledgements

I would like to dedicate this thesis first and foremost to God. My ability to achieve at such a high level with continual commitment and passion is because of my relationship and commitment to Jesus Christ. Throughout this research I have encountered several challenges and developments, but nothing has grounded me or kept me going as much as my faith has. Thank you also to all the sport scholar participants for their contribution to my research. I know that without their involvement, this research would not have been possible.

A big thanks to my two supervisors, Dr Mike Hamlin and Dr Gary Steel for supervising me throughout my research. Their input has been essential for the success of my Masters. This research would not have taken place if it was not for their assistance. Mike Hamlin was always there for me along this academic journey, providing input, suggestions, corrections, and good discussions. Gary Steel was a great help for guiding my well-being in this research, always providing sincere conversations outside of the academia world.

Sincere thanks to my husband Isaac David Wilkes, who has stood by me and supported me throughout my two years of completing my Master of Applied Science. We even managed to plan and achieve a wedding in amongst all my research commitments. His encouragement and insight through it all helped me to explain my research and has helped me to have fun along the way. I could not have done it without his continual support.

I would also like to thank my family and friends who helped make this journey an enjoyable one. I could not have completed this thesis without the support of my mother, my sisters, and my close friends. Each one of them played a vital role in helping me stay committed and encouraged me to finish. My mother was paramount for my success because she would remind me of how far I have come, and how close I was to finishing.

Lastly, I would like to thank Lincoln University for their assistance and support. They played a crucial role in ensuring that I kept to my deadlines and ethical submissions.

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## Glossary

- Stress - a deviation from a norm or steady state and is a relationship between an individual and the environment where there is perception of a situation exceeding or taxing resources and endangering well-being (Lazarus and Folkman, 1984).
- Athlete - an individual that carries absolute expertise in a chosen sport and has the potential to reach the highest standard in their sport, nationally or internationally (Swann, Moran, and Piggott, 2015).
- Metrifit - software used in multiple countries that allows athletes to complete subjective information about their well-being and training responses (MetriFit, 2017).
- Sport scholars - an athlete that manages two full time roles between sport and tertiary education (O'Neill, Allen, and Calder, 2013).
- Wellness - subjective or emotional wellbeing that is commonly evaluated based on the presence of positive affect, the absence of negative affect, and the perceived satisfaction when a person approaches valued goals and rewarding events or stimuli (Lundqvist and Raglin, 2015).

## Abbreviations

- RPE – Rate of Perceived Exertion
- RTT – Readiness to Train
- ACHA - American College Health Association
- Min - Minute

For ease of confusion throughout this thesis, the terms 'athletes' and 'sport scholars' are used interchangeably.

## 1.0 INTRODUCTION

In sport, achieving a balance between stress, recovery, and performance for athletes is crucial for success (Kellmann, 2010). Physical and psychological recovery for athletes has gained greater attention in the literature over the past ten years due to the importance of overall performance and health for these athletes (Kellmann, 2010). Typically, athletes encounter stress from training and competition, but also from various lifestyle factors, which could determine sporting success or failure (Bishop, Jones, and Woods, 2008). Coaches and support staff use various recovery modalities and monitoring tools to balance and monitor the stress and wellness of athletes to help athletes perform at their best, as well as manage things that are not going so well. Even with this new knowledge around stress and recovery it is debatable whether these techniques have been successful in reducing overtraining, injury, illness, fatigue, and burnout in athletes (Kellmann, 2010). When stress through training and other areas like psychological stress overcome an athlete's stress coping ability, athletes can experience overtraining, injury, and illness. Disturbances of the hormonal, immunologic, and neurologic systems of the body can occur from stress (Kreher, 2016). Further stressors from unbalanced training and recovery can place an athlete into an unhealthy state where they are unable to maintain the required or expected force (power output), either short term or long term (Winsley and Matos, 2011).

Despite wellbeing research expanding in interest, there are still recognised gaps in how wellbeing is defined and measured, with further confusion around the interchangeable use of other terms such as happiness, life satisfaction, quality of life, and wellness (Hartwell, 2013). This study is looking at subjective wellbeing measures created by Metrifit to monitor an athlete's body, mind, training, as well as injuries and illnesses.

Full-time athletes undertaking full-time tertiary study simultaneously (referred to as sport scholars) are a unique sports population because they not only have to perform in their sport at a high level, they also have the additional stress of achieving sufficient academic results, all whilst maintaining a healthy well-being. There is little research around the best way to monitor athletes such as sport scholars.

This research had several objectives. Firstly, I wanted to see if stress changed between year groups (for example were first-year athletes under more pressure than second-year and third-year athletes). The second purpose of this research was to identify potential differences between female and male athletes as a way to better aid the individual athlete's needs. The third purpose of this research was to identify which factors influence academic pressure levels. The final purpose of this research was to analyse what contributes to how athletes rate their sport performance.

More specifically, this research explored the following objectives:

1. To analyse indicators of stress and wellness between first-year, second-year, and third-year athletes: measured through perceived academic pressure, perceived energy levels, perceived muscle readiness, perceived mood state, perceived sleep quality, perceived sleep duration, weekly training load, and weekly training volume
2. To analyse indicators of stress and wellness between female and male athletes: measured through perceived academic pressure, perceived energy levels, perceived muscle readiness, perceived mood state, perceived sleep quality, perceived sleep duration, weekly training load, and weekly training volume
3. To analyse the main measures that are related to or associated with academic pressure. The variables that are of interest are; readiness to train (RTT), perceived muscle readiness, weekly training load, weekly training volume, perceived energy levels, perceived mood state, sleep duration, and perceived sleep quality
4. To investigate relationships between the athletes perceived athletic performance and measures of training and psychological stress. The variables that are of interest are; weekly training load, weekly training volume, sleep quality, sleep duration, perceived academic pressure, perceived energy levels, perceived mood state, and perceived muscle readiness

This thesis initially provides a review of the literature related to the monitoring of athletes, followed by a description of the method utilised in the stages of this

research. The main findings of the study and discussion of these results are provided in the subsequent sections.

## 2.0 LITERATURE REVIEW

### 2.1 Introduction

The following section provides an overview of the literature and contemporary research that relates to monitoring athletes that also undertake full-time tertiary study. The information currently available on athlete monitoring can be overwhelming. This section will provide relevant and practical information by first defining the theory of training and identifying the main findings situated around stress on the body from training. It will then discuss what has been found around monitoring athletes, and then go on to explain common variables used to monitor athletes, as well as the current findings based from these variables used.

### 2.2 The Theory of Training

An athlete's performance is the result of accumulated training and subsequent recovery sessions. Training is designed to overload the body, mainly through the cardiovascular and muscular system, which then stresses the body. Monitoring an athlete's stress response to an individual training session is paramount for gauging how an athlete is adapting. (McGuigan, 2017). However, an athlete's stress response to training can be due to more than just the training programme. There are various factors that can influence an athlete's stress response to training, including; personality, genetics, training history, sleep quality and sleep duration, academic pressure, family pressures, and more (Mellalieu, Hanton, and Fletcher, 2009). To understand the theory of training, it is paramount to understand the concept of stress.

The concept of stress has been identified as early as the 14th century (Lazarus, 1993). Stress represents a deviation from a homeostatic norm and can be influenced by the relationship between an individual and the environment where there is perception of stress exceeding resources and endangering well-being (Lazarus and Folkman, 1984). Stress can be overwhelming, leading to inadequacy to recover or adopt effective strategies for coping (Kellmann, 2010). In the late 1940's there was minimal public or scientific interest in stress (Lazarus, 2006). However, after World War I and II, psychology research developed around stress, particularly the understanding of stress as a concept. During World War II, significant

interest came from looking at emotional breakdowns with soldiers in response to stress, and how they found meaning in their difficulties (Lazarus, 1993). Stress affects more than just performance, it also effects social, physiological, and psychological health (Lazarus, 2006). Unresolved stressors have been directly linked to adverse health outcomes such as coronary heart disease, gastrointestinal distress, and cancer, all of which have a negative impact on human survival, and ultimately a decline in life expectancy (Vietta, Anton, Cortizo, and Sali, 2005). Stress can help an individual achieve goals and stimulate positive productivity if short-lived, but unresolved chronic stress can become crippling to human well-being, leading to physical and psychological illness (Colligan et al., 2006). Selye (1970) reports that the adrenal cortex responds with increased secretion upon exposure to stressors, emphasising the biological underpinning of stress. Later in his career, Selye (1973) distinguished the difference between eustress and distress, with eustress being caused by positive experiences such as falling in love, and distress being caused by negative experiences such as grief.

Athletes commonly encounter stressors because of their high level of involvement in sport for extended periods of time (Galli and, Gonzalez 2015). These stressors include injury or illness, performance failures, coach demands and expectations, as well as competing whilst injured, watching other competition, large crowds, and weather conditions (Mellalieu, Neil, Hanton, and Fletcher, 2009). Training is a common requirement associated with exercise prescription and aims to provide the body with adequate physical stressors to generate adaptive changes, resulting in improved performance (Myrick, 2015). This can be seen as the acute challenge to the body that is intended to optimize chronic improvements in physiological capabilities (Bishop, Jones, and Woods, 2008). In professional sport, training is seen to be an important requirement for athletes because it ensures adequate physical development (Gabbett, Whyte, Hartwig, Wescombe, and Naughton, 2014).

There has been a considerable amount of research looking at the adaptations to exercise training over the last few decades (Birch and George, 1999), some of which has investigated the influence of training volume, training intensity, and frequency on athletic performance (Gabbett et al., 2014). Training volume can be understood as the frequency, duration, and intensity of a training programme (Halsen, 2014). In 1996 Foster originally proposed a method of determining training load by multiplying the session intensity by the duration, which is expressed in arbitrary units, commonly known as the training impulse (or Trimp) (Malisoux, Frisch, Urhausen, Seil, and Theisen, 2013). Depending on the age and the



experience of the athlete, the duration and intensity of a training programme can aid in determining whether an athlete is adapting to their training programme and minimizing the risk of overtraining, illness, and injury (Halson, 2014). Therefore, many athletes, coaches, and support staff are now investigating the duration and intensity of training from a scientific perspective to improve the wellbeing and overall performance for the athlete.

### 2.3 Overreaching and Overtraining

The human body is extremely adaptable, yet the difficulty lies in finding the correct balance between maximizing a training response and avoiding overtraining (Ball and Herrington, 1998). A natural short-term occurrence from training is overreaching. Overreaching is referred to as excessive physical training, incomplete recovery, and high general stress that may manifest in short-term performance reduction (Coutts et al., 2007). Overreaching is a key principle of physical training that is necessary for improving performance by adding stress on an athlete that increases that adaptation effect (Purvis, Gonsalves, and Deuster, 2010), and induces a performance super-compensation (Coutts et al., 2007). Overreaching occurs when there is a sudden short-term drop in performance despite an increase in training load (Hug, Mullis, Vogt, Ventura, and Hoppeler, 2003), and is usually recovered with immediate rest. It has been assumed that adequate recovery in minor forms of overreaching can quickly resolve physiologic states (Kreher, 2016), and is a balance of overload and adequate recovery (Purvis et al., 2010).

Athletes deliberately overload their bodies with training so that in the recovery period, adaptations are superior, and result in enhanced physical conditioning and performance (Winsley et al., 2011). The key with overreaching is to experience an increase in pressure and demand for only a short period of time before allowing for sufficient recovery. When an athlete is under stress from training for too long without adequate recovery, they experience overtraining, often referred to as 'staleness' 'burnout' and 'chronic fatigue' (Birch et al., 1999). Excessive stress is the cause of overtraining (Griffin and Unnithan, 1999), which can come from sport specific and non-sport specific stressors combining to negatively affect the athlete for a prolonged period, even with rest (Winsley et al., 2011). Overtraining can lead to performance decrements and non-sport related impairments, including financial, social, emotional, psychological, spiritual, and mental, where an athlete's personal life is negatively

affected (Purvis et al., 2010). The harder and longer an athlete trains without sufficient rest, the more susceptible they are to overtraining.

Overtraining was a term commonly used by the European College of Sport Science in 2006 as a way of understanding the difference between overreaching and overtraining (Purvis et al., 2010), and results in an impairment rather than an improvement in performance (Bishop et al., 2008). Overtraining is seen to be more prevalent in individual sports than team sports and is also more prevalent in females than males (Winsley et al., 2011). It also appears that for females, the reproductive system is more affected than for males with overtraining (Birch et al., 1999). Female athletes differ to male athletes where they require greater amounts of energy to allow for normal menstrual function in addition to energy expenditure for performance (Birch et al., 1999). Female athletes are also likely to be more vulnerable to certain stressors than males, such as emotional stressors, friendship stressors, and social media stressors (Winslet et al., 2011). Crocker and Graham (1995) suggest that females are expected to reach out to their social support network more often than males when under stress. This correlates strongly to the sex role stereotypes that females and males differ in their ability to talk with others when difficult situations arise (Crocker et al., 1995).

In severe cases of overtraining, the body is no longer able to accommodate stressors, recovery is no longer achieved, and negative health symptoms result (Myrick, 2015). An overtrained athlete generally sustains a low-grade trauma that resembles an overuse injury resulting from high-volume training (Margonis et al., 2007). It can be difficult to detect overtraining due to the limited scientific information on the symptoms of overtraining (Padalino, Rubino, Centoducati, and Petazzi, 2007). Both overreaching and overtraining have also been identified through athletes involved in community sport and clubs both nationally and internationally (Winsley et al., 2011), as well as in both competitive and recreational athletes (Birch et al., 1999).

## 2.4 Recovery

The key to minimising overtraining is recovery. Recovery is seen to be one of the most important phases of any training process because it prevents the body from experiencing too much fatigue (Birch et al., 1999). Coaches and researchers emphasise the importance of recovery to allow an athlete to train more, and to optimize their overall fitness and performance. (Kellmann, 2010). During the 2008 Olympics Games in Beijing, the Australian

Institute of Sport and the US Olympics Committee provided recovery facilities for their athletes to recover throughout the duration of the games. The aim of this initiative was to optimize athlete performance (Kellmann, 2010). When looking at the concept of recovery in relation to sports training, recovery can be categorized into three terms. These terms are immediate recovery, short-term recovery, and training recovery (Bishop et al., 2008). Immediate recovery is understood to be the recovery between rapid, time-proximal finite efforts (or recovery between immediate exertions). Short-term recovery is understood as the recovery between sets. Training recovery is understood as the recovery between successive work-outs or competitions (Bishop et al., 2008). These recovery terms carry importance for improvement and recuperation of athletes (Myrick, 2015).

Despite the significant importance of recovery from training, many coaches and athletes pay sparse attention to recovery due to the pursuit to train hard and win at all costs mentally, resulting in their training outweighing their recovery, ultimately leading to overtraining (Birch et al., 1999). When athletes experience high demands and pressures from training and not enough recovery, continued training without adequate recovery will result in continued fatigue, performance decrements, and long-term health problems, known as overtraining (Birch et al., 1999). The amount of sufficient recovery varies depending on athlete physiological and psychological profiles (Bishop et al., 2008).

## 2.5 Monitoring Athletes

Monitoring an athlete's well-being is crucial to guide training and to detect any indicators of negative health and associated poor performance before it becomes severely detrimental or permanent (Saw, Main, and Gustin, 2015). Monitoring also helps sport coaches to measure the effectiveness of their training programme to decide on whether to modify or update their training programmes (McGuigan, 2017). Factors such as genetics, training history, and personality can all play a crucial role in how an athlete responds to training stressors; therefore, monitoring an athlete should be individualized (McGuigan, 2017). In recent decades, mental recovery in sport has received significant attention in research and practice due to the link between the physical and mental state (Kellmann, 2010). Psychological variables can detect changes in both fatigue and muscle soreness (McLean, Coutts, Kelly, McGuigan, and Cormack, 2010). It is becoming rare for elite or professional athletes to not be involved in some type of psychological and physiological monitoring

(McGuigan, 2017). Because of this, sport coaches, sport managers, and sport scientists need to be well equipped and understand how to use the findings generated from monitoring their athletes (McGuigan, 2017). Over the past decades, sport coaches and sport scientists have been gathering significant information about athletes, using a wide range of technologies to do so. Questionnaires and diaries are examples of self-report measures that are suggested to be simple and cost-effective ways to monitor an athlete's response to training (Saw et al., 2015). The challenge for sport coaches and sport scientists is to collect data that will prove beneficial to the long-term achievements of an athlete, as opposed to gathering information without knowing what to do with it.

Many athletes actively engage in the practice of routinely recording their training, performance related behaviours, and their perceived wellbeing scores (Saw et al., 2015). Such instruments are designed to reflect recovery-stress state of an athlete, and can include mood state, sleep quality and sleep duration, general stress, emotional stress, academic stress, social stress, energy levels/lack of energy, injury, training load, strain, monotony, and diet. Measures of subjective well-being have been shown to demonstrate changes with changes in training stress, with pre-warning of performance and psychological problems (Neumaier, Main, and Gatin, 2013). If used properly, such instruments can provide information about athletes relatively quickly, which can lead to interventions to reduce indications of stress, including fatigue, injury, illness, burnout, and insufficient recovery (Saw et al., 2015).

## 2.6 Instruments Used

There are many ways an athlete's state of being can be measured. The 'Recovery-Stress Questionnaire for Athletes' (RSQ), 'Total Quality of Recovery Scores' (TQRS), and 'Profile of Mood States (POMS) Questionnaire' are all commonly used instruments that provide predominately psychological data on athletes. POMS is a common go-to for sport scientists, with a recently conducted study in 2018 using POMS to measure soccer athlete's mood state fifteen minutes before and fifteen minutes after training as a way of evaluating their mood state in relation to their rate of perceived exertion (RPE) (Selmi, Khalifa, Zouaoui, Azaiez, and Bouassidaa, 2018). The 'Recovery-Stress Questionnaire for Athletes' has been used in various sports to measure recovery-stress states for athletes through 7 general stress scales (general stress, emotional stress, social stress, conflicts/pressure, fatigue, lack of energy, and physical complaints) (Kellmann, 2010). This monitoring instrument has found that

increase in training volume and intensity were reflected by changes in psychological scores such as stress levels, energy levels, and mood states. Increase in training loads were associated with a decrease in mood state, demonstrating the relationship between training and stress (Kellmann, 2010). Purvis, Gonsalves, and Deuster (2010) also found the same relationship between training and mood state, where mood state disturbances increased during a high-volume training season, and then reverted to baseline during recovery.

These findings would not have come about without correct analysis of the data from athletes who have tracked these measurements. Such findings give confidence to coaches and sport scientists that the well-being of athletes can be accurately monitored to ensure efficient and effective training.

### 2.6.1 Sleep

One of the most commonly used measures for monitoring athletes is sleep. Common measurements for sleep are carried out through subjective questionnaires. However, subjective questionnaires on sleep have been shown to have a poor relationship to objective measures of sleep. Despite this finding, objective measures such as polysomnography (an assessment of electroencephalogram and other physiological variables) of sleep can be rather intrusive and require access to a sleep laboratory with specialist staff, which can be inconvenient and expensive (Leeder et al., 2012).

There is a strong association between sleep and athletic performance (Roky et al., 2012). When an athlete is deprived of sleep over a lengthy amount of time, illusions, hallucinations, and unforeseen behavioural episodes occur (Reilly and Deykin, 1983). Sleep is a basic requirement for health and recovery that is believed to be related to homeostatic processes that rejuvenate and replenish major physiological and psychological functions of the human body (Lastella, Roach, Halson, and Sargent, 2015). There is ongoing controversy around how much sleep an athlete requires per night, with recent studies from National Sleep Foundation suggesting that healthy adults should obtain anywhere between 7 to 9 hours of sleep per night to carry out daytime functions (Sargent, Lastella, Halson, and Roach, 2014). Athletes are expected to have approximately 8 hours of sleep per night to prevent the neurobehavioral deficits associated with sleep loss (Lastella et al., 2015). Athletes are frequently exposed to intense physiological, psychological, and emotional demands to

perform successfully (Crocker et al., 1995). Frequent exposure to such conditions increases an athlete's need for recovery, resulting in an increased need for sleep (Lastella et al., 2015).

Athletes take longer than sedentary individuals to get to sleep and require more hours of sleep daily (Reilly et al., 2007). Sleep is expected to be beneficial after exercise due to the traditional hypotheses that sleep allows energy conservation, body restoration, and thermoregulatory functions to operate. (Drivers and Taylor, 2000). Lack of sleep is shown to have detrimental effects on physiological and psychological performance (Leeder, Glaister, Pizzoferro, Dawson, and Pedlar, 2012). The most prevalent effects of sleep loss are psychological, with the primary affect being associated with altered mood states, decision making skills, and cognitive impairment (Davenne, 2009). Decision-making skills are frequently incorporated into sport, and when sleep duration and sleep quality is not constantly prioritised, the cognitive processes involved in decision making during sport decreases, thus decreasing performance outcomes (Reilly et al., 2007). It seems that gross motor functions during sport are less affected by sleep loss than the tasks requiring fast reactions (Reilly and Edwards, 2007). Additional psychological effects from sleep loss include memory impairment, decreased vigilance and reduced sustained attention, as well as a shift in optimum response capability (Davenne, 2009). Physiological effects with sleep loss are not so prevalent but are linked to reduced immune function (via reductions in natural killer T cells) (Reilly et al., 2007), decreased sub-maximal sustained performance (Leeder et al., 2012), and a decline in recovery, resulting in increased fatigue (Davenne, 2009).

Based on anecdotal evidence, sleep is the most effective recovery strategy (Leeder et al., 2012). Sleep for an athlete allows the physiological processes of recovery to occur from a cellular level. A study conducted in 2012 found that a group of 47 Olympic athletes during a typical out-of-training phase took longer to fall asleep, spent more time awake in bed, had lower sleep efficiency, and higher sleep fragmentation (Leeder et al., 2012). These findings can be related to inconsistent sleep patterns due to sports training. Additional to this, a study conducted in 2013 found that athletes who trained in the late afternoon (4:30 pm-6:30 pm) reported later bed times and later wake times than when they did not train, or when they trained lightly during the day (Robey, Dawson, Halson, Gregson, Goodman, and Eastwood, 2013). Both studies demonstrate awareness towards sleep and the influence on athletic performance. Attaining successful performance for any athlete requires cohesion with

coaches and support staff, as well as a planned approach to ensure a balance between training and recovery, including sleep (Sargent et al., 2014).

Athletes' may be able to recover from the adverse effects of sleep loss in single all-out efforts, however, it becomes substantially more difficult to recover from sleep loss over longer periods of training sessions, making them unable or unwilling to maintain high performance continuously (Reilly et al., 2007). The task required of the athlete can also determine their ability to cope with short-term sleep loss, with Reilly and Edwards (2007) finding that athlete's carrying out bicep curls were able to successfully execute the movement, despite having lacked sleep. On the other hand, bench press, leg press, and deadlift were exercises that had a significant decrease in performance from sleep loss (Reilly et al., 2007). These findings indicate that complex lifting tasks are more affected by sleep loss than simple tasks.

Factors such as gender, personality, and sport can all affect an athlete's sleep patterns, with Leeder, Glaister, Pizzoferro, Dawson, and Pedlar (2012) suggesting that females have substantially better sleep quality than males of the same age range (Leeder et al., 2012). Contrary to this, Reilly and Edwards (2007) suggest that the effects of sleep deprivation are the same for females and males. The explanation for these findings on gender are not entirely known due to limited research in this area, demonstrating the need for further research to be conducted on the differences in sleep patterns and sleep loss between females and males. Personality traits can impact on an athlete's sleep pattern by influencing the time an athlete goes to sleep, with extroverts tending to cope better than introverts with a delayed bedtime, and introverts being more suited to 'morning-type' behaviour (Reilly and Edwards, 2007). Different sports also influence athletes sleep patterns with the combination of factors such as training volume and intensity, frequency of training, psychological stress of training (particularly with pre-competition training), and external factors such as work, family, and academic commitments (Leeder et al., 2012). Differences in sport competitions and stages of training also accounts for variability in sleep patterns.

### 2.6.2 Mood State

In the last decade, knowledge around regular involvement in sport and physical exercise has accumulated to demonstrate the improvement on wellbeing and emotional state (Van Wilgen, Kaptein, and Brink, 2010). Recent studies have also indicated an improvement

in mood after participation in aerobic exercise (Netz and Lidor, 2003). Mood fluctuates during and after exercise and can be an easy assessment for early indicators of overtraining of athletes (Kellmann, 2010). Intensified training for athletes can affect their mood state with exhaustion after exercise tightly associated with increased anxiety, anger, hostility, and depression. However, moderate training is associated with a positive mood state (Selmi et al., 2018). Mood state can be used as an effective tool to assess emotional states of athletes as well as adaptive response to training (Selmi et al., 2018). There are mixed findings however, with Selmi et al. (2018) demonstrating that soccer players described increased tension, fatigue, and a decrease in vigour after high intensity interval training (HIIT), whilst another study conducted by Nalcakan et al. (2017) suggested that after sedentary individuals completed HIIT, there was an increase in positive affect and vigour, with a decrease in depression, tension, and total mood disturbances. These contrasting findings can be due to athletic and sedentary individuals, with athletes undergoing greater intensity of training over periods of time.

Further to the intensity of training, mood state can be altered by sleep loss, which increases depression, tension, confusion, fatigue, and anger (Reilly et al., 2007). Although the aim of this research is not focusing on athlete injuries and the consequences from this, it is important to note that an athlete's emotional state is strongly influenced and changed across time by experiencing injuries from sport, where athletes create mental representations of their injury in order to recover (Van Wilgen et al., 2010).

## 2.7 Sport Scholars

There has been inconsistency and confusion around the definition of athletes within the literature (Swann, Moran, and Piggott, 2015). Despite the ten-year criteria before someone becomes titled as an 'athlete', there have been individuals identified as athletes with as little as two years' experience (Swann et al., 2015). Athletes appear to range from Olympic champions, professional performers, members of national squads, and athletes from a competitive team, demonstrating a range of inconsistency. For simplicity, athletes can be understood as an individual that carries absolute expertise in a chosen sport and have the potential to reach the highest standard in their sport, nationally or internationally (Swann et al., 2015).



Some athletes are students as well, and many athletes take up tertiary study as a fall-back option in case their athletic dreams are not met. However, like elite sport, tertiary study also involves stress and worry. The American College Health Association (ACHA) provide data on stress and its relationship to university students, and shows some students recorded high levels of sleep difficulties, as well as depression and anxiety, feelings of hopelessness, exhaustion, and being overwhelmed during their studies, with some students even considering suicide (American College Health Association, 2009). These findings demonstrate the vulnerability and uncertainty that university students undergo. To then load professional sport commitments on top of this can add greater distress. ACHA findings are consistent with Robotham and Julian (2006) who also concluded that stress can have a detrimental impact on students well-being, causing physical and mental illness, including anxiety, depression, and even suicide.

Athletes undertaking tertiary study (e.g., sport scholars) are a unique sports population because they not only have to perform in their sport at a high level, they also have to achieve academic results at a high level to maintain their scholarship. Athletes that manage two full-time roles between sport and education encounter several potential and anticipated stressors that are additional to full time athletes or full time tertiary students (O'Neill, Allen, and Calder, 2013). Sport scholars have been identified in the literature as a disadvantaged population because of their constant conflicts between athletic and academic commitments where they are forced to cope with issues such as missing class, extended travel, constant physical training, and added demands that non-athletes do not experience (Powell, 2009). Additional stressors include time availability and management, social and organisational skills, developmental challenges, physical and psychological demands, and daily experiences quite unlike full-time athletes or full-time students (Arvan, 2010). Sport scholars are sometimes under-prepared and normally receive lower grades than their non-athlete peers due to their different cognitive development and the need to execute two demanding roles daily (Symonds, 2009).

Pascarella et al (1999) suggest that athletes have more favourable support than non-athletes. Sport scholars are a small scale population that need to be supported for their athletic performance alongside their studies and future career opportunities. This growing

population need to balance sport, academic, and other tertiary expectations, which can result in prolonged stress and anxiety (Pascarella, Bohr, Nora, and Terenzini, 1995).

This research revolves around the special population of athletes that are also undertaking tertiary study. These sport scholar students are unique in that they must perform to a high standard on the sports field or stadium and in the gym. They must also meet academic expectations by passing their university courses. Such athletes are under unique stresses as they try to manage their study, sport and social life. This thesis will look at a snapshot of these athletes over a period of 4 years to find out how and when they are stressed, and whether the stress is different between certain groups by using the daily monitoring these athletes are required to complete as part of their scholarship commitments.

### 3.0 METHOD

This longitudinal retrospective cross-sectional study used a commercially available software system (Health and Sport Technologies Ltd, trading as Metrfit, Millgrange, Greenore, Co. Louth, Ireland) to track and log an athlete's data through physical and psychological measures. Metrfit was founded in 2010 by Peter Larkin and is a commercial athlete monitoring software package used by all Lincoln university sport scholars. From January 2014 to August 2017, the data for this study included first-year, second-year, and third-year sport scholars, with many athletes being included in multiple years of the data. The data was collected 3-4 weeks prior and then throughout the athlete's academic year. The academic year typically includes two semesters. Each semester covers 12-weeks of teaching. Each semester is interrupted mid-way with a 2-week holiday break. After 12 weeks of teaching there is 1-week of study break followed by a 2-week final exam period to close the semester. There is a 4-week break between semesters, and a summer holiday of 15-weeks prior to the start of the next university year in February.

#### 3.1 Subjects

The research consisted of 183 participants who were aged 18-25 years old undertaking undergraduate sport scholarship programmes at Lincoln University during 2014-2017. Athletes received nutritional, psychological and medical advice along with individualized training. Most participants were selected for age-group provincial or national representative honours, meaning they were at a very high level of sport competition for their age group. All participants gave their written informed consent in accordance with the Declaration of Helsinki.

#### 3.2 Recruitment

All athletes were recruited from their sport scholarship programmes when they enrolled during the time of January 2014 to August 2017. All athletes were informed in their inductions about the use of Metrfit and its use of anonymous data to be analysed to improve their performance. Athletes were given briefings and training prior to commencing their Metrfit data entry to ensure that they understood what data they needed to include, and how to interpret the questions. They were taught how to log into Metrfit and how to navigate

around the system. Athletes were told that Metrifit is a performance monitoring tool used to plan, monitor, and record training and lifestyle habits of athletes to empower both the athlete and the coach/staff, allowing the athlete to have autonomy for making choices, develop higher levels of motivation, and develop solutions to enhance their own performance. Athletes were taught the four cornerstones of their data: physical, psychological, technical, and community. Physical was described as training, nutrition, tests, and competitions. Psychological was described as goal setting, body and mind, and performance analysis. Technical was described as video analysis, tactics, skill evaluation, and training. Lastly, community was described as messages, library, social networking, and coach's blogs.

Athletes were told of the benefits of using Metrifit, where they can measure, understand, control, and improve their performance. Athletes were given case studies of successful data entry into the software, and they were taken through the reports used, such as injury reports, training load reports, body and mind reports, nutrition reports, and more. They were informed on the readiness to train (RTT) measure, being told that the RTT calculation uses subjective indicators, and produces a daily readiness to train score. This can be invaluable to view before training and matches to individualise training if required and help keep athlete's injury-free. The RTT score is a performance related variable created by Metrifit to provide a percentage score on whether an athlete is ready to train. This is based on a 1-5 Likert-type scale, with 1 = 0, 2 = 1, 3 = 10, 4 = 20, and 5 = 25. The 6 variables used for the RTT score all carry a different weighting. For example, perceived mood state contributes to 15% of the overall score, perceived sleep quality contributes to 20% of the overall score, perceived energy levels contribute to 30% of the overall score, perceived muscle readiness contributes to 15% of the overall score, diet contributes to 10% of the overall score, and perceived academic pressure contributes to 10% of the overall score. Athletes were also taught how to log injury and illness correctly should this occur, and shown measures included in body and mind section which is mostly psychological measures.

Both physical and psychological measures were required to be entered by the athlete each day throughout the year/s they were involved with the scholarship programme. The in-house questions are similar to that used by McLean (2010), which is based on the recommendations of Hooper and Mackinnon (1995), and ask the athletes to rate their overall stress through perceived academic performance, perceived sleep quality, perceived sleep duration (numerical), perceived muscle readiness (soreness), perceived energy levels,

perceived mood state, training duration (numerical) on a 5-point Likert-type scale (1: Very poor, 5: Very good) each day. Athletes were told that these measures were subjective, so could not be wrong. The week's average score for each variable was then tallied for this study. Perceived academic pressure was the one variable that used a reverse 5-point-Likert-styled scale (1: High academic pressure, 5: Little to no academic pressure).

Further measures such as weekly training volume (duration of training in minutes), and weekly training load (duration of training in minutes x rate of perceived exertion, where perceived exertion was based on a Likert-type scale from 1-10 from athletes, before staff and coaches carry out the weekly calculation) were explained to athletes. Demographic data consisting of name, date of birth, sex, year of academic study, sport played, and position in that sport was also collected. Other subjective measures recorded but not used in this study were illness, injury, rate of perceived exertion, strain, health, and diet. Daily training information was monitored by all participants and then converted quantitatively into training impulse. This was then calculated as the product of training duration (min). In addition, training volume was also recorded simply as the weekly minutes of activity.

### 3.3 Procedure

Data sheets on Microsoft Excel were gathered by Anna Bruen, who is involved in the development of the Metrifit system. Anna Bruen was contacted by the researcher via email to request permission for using this data in the study. Anna Bruen sent through the requested data for this study, including all data entries from January 2014 to August 2017 of perceived mood state, perceived sleep quality, perceived sleep duration, perceived energy levels, RPE, perceived muscle readiness, perceived academic pressure, strain (monitors overtraining through weekly training load x weekly monotony), monotony (variation in both training and training intensity), weekly training volume, weekly training load, as well as name, sex, date of birth, sport, position of sport, and a user ID number. There were 17 different sports included in this study: netball, football, basketball, hockey, rowing, cricket, golf, cycling, triathlon, athletics, equestrian, dance, aerobics, martial arts, canoeing, and other. The data was anonymised with ID numbers and was then entered to Microsoft Excel spreadsheet for further analysis.

### 3.4 Statistical Analysis

SAS, Version 9.3 was a statistical analysis system used to analyse the data. The data was split into year levels where the proc means procedure was used to calculate the means of the different variables in the groups based on year level. The difference between the three groups was analysed using the proc means procedure. Changes in the mean of the variables and standard deviations representing the between-and within-subject variability were estimated using a mixed-modelling procedure in the Statistical Analysis System (Version 9.3, SAS Institute, Cary North Carolina, USA). Chances that the true effects were substantial were estimated when a value for the smallest worthwhile effect was entered into the calculation. We used 0.20 standardized units (change in mean divided by the between-subject SD at baseline) as the smallest worthwhile change (Cohen, 1988). To make inferences about the true (population) uncertainties, the estimate of change was presented as 90% confidence intervals, and as likelihoods that the true value of the effect was increased, decreased, or trivial. The descriptors (increased, trivial, or decreased) were used to describe the direction of the change. Where the confidence interval spanned all three possibilities (increased, trivial and decreased), the result was deemed unclear. In all other cases, such as no overlap, or an overlap between 2 possibilities (trivial and increased, or trivial and decreased) a clear result was achieved. The magnitude or probability of the change was assessed using a qualitative scale defined as: <0.5%: almost certainly not; <5%: very unlikely; <25%: unlikely/probably not; 25–75%: possibly, possibly not; >75%: likely, probably; >95%: very likely; and >99.5%: almost certainly. This procedure was used to determine the association between academic stress and other variables. Finally, a step-wise linear regression was used to identify which variables were associated with academic stress.

### 3.5 Ethical Considerations

Prior to the participation of this study, the researcher provided written explanations to the Lincoln University Human Ethics Committee, explaining the purpose of this research, specifically mentioning that publications of results from this study will only be aggregated means and standard deviations of groups rather than individuals. To ensure anonymity, participants were provided with identification numbers that kept their personal information

excluded from the study. This research was approved by the Lincoln University Human Ethics Committee (Reference 2018-01).

### 3.6 Method Limitations

The method limitations of this study primarily relate to the large study population and data generated. This meant that the data would not be analysed to focus on an athlete's individual progress, but instead analysed as a large group. This generalised the findings from this research to first-year, second-year, and third-year, as well as female and male athletes, rather than individual athletes. Another method limitation regarding the study population that provided difficulty in the analysis of the data was due to the large quantity of data entries, requiring continual changes on Microsoft Excel and SAS, Version 9.3, as well as lost data and slow software. It is also important to note another limitation to the method is the adherence/response rates (34% in semester 1 then 21% in semester 2 for weekly subjective data, and 20% in semester 1, then down to 10% in semester 2 for weekly training data) to complete daily entries. This low response rate could have a strong impact on the quality/quantity and accuracy of results for different groups, and therefore needs to be considered when reviewing results.

## 4.0 RESULTS

Between January 2014 to August 2017, 237 sport scholar athletes aged 18-25 years, both female and male started a scholarship at Lincoln University. Of the total 237 sport scholars, 54 athletes were removed from the sport scholarship programme, leaving 183 athletes who remained in the sport scholarship programme, and successfully loaded their daily training information onto the Metrifit software system. Of these 183 athletes, 132 of them were male, and 51 of them were female. The average completion rate for subjects entering their weekly subjective data was 34% in semester 1 and 21% in semester 2. Similarly, in semester 1 only 20% of subjects entered their weekly training data which reduced down to 10% by semester 2.

### 4.1 Indications of stress and wellness between first-year, second-year, and third-year athletes

Table 1. Subjective Training Variables in each semester over a 4-year Period.

Variable	Year1		Year 2		Year 3	
	Sem 1	Sem 2	Sem 1	Sem 2	Sem 1	Sem 2
Mood	3.8 ± 0.7	3.8 ± 0.6	3.7 ± 0.6	3.8 ± 0.6	3.7 ± 0.7	3.6 ± 0.7b,d
Energy	3.7 ± 0.7	3.7 ± 0.6	3.6 ± 0.6	3.6 ± 0.7	3.6 ± 0.7	3.5 ± 0.7b
Sleep Quality	3.6 ± 0.9	3.6 ± 0.8	3.5 ± 0.8	3.5 ± 0.8	3.5 ± 0.8	3.4 ± 0.8b
Sleep Duration (hrs:mins)	8.1 ± 1.3	8.3 ± 1.2	8.1 ± 1.2	8.2 ± 1.1	7.9 ± 1.3	7.9 ± 1.3b,d
Muscle Readiness	3.9 ± 0.8	3.8 ± 0.8	3.7 ± 0.8a	3.7 ± 0.7	3.8 ± 0.8	3.8 ± 0.8
Academic Pressure	3.7 ± 1.00	4.0 ± 0.9	3.8 ± 1.0	3.8 ± 0.8	3.8 ± 1.0	3.6 ± 0.9b,d
Training Load (au)	1591±1021	1498±1040	1600±1098	1492±1033	1764±1345a,c	1225±890b,d
Training Volume (min)	286± 175	273 ± 192	280 ± 187	275 ± 200	304 ± 208	214 ± 144b,d

Data is mean ± SD. Values are based on a 5-point Likert scale except for sleep duration which is hours, where 1 = poor, and 5 = very good for all variables except academic pressure where 1 = high academic pressure, and 5 = low academic pressure. Training load is given in arbitrary units while training volume is given in minutes <sup>a</sup>Substantially different from semester 1 year 1. <sup>b</sup>Substantially different from semester 2 year 1. <sup>c</sup>Substantially different from semester 1 year 2. <sup>d</sup>Substantially different from semester 2 year 2.

First-year, second-year, and third-year athletes experienced different levels of pressure during their time at university between Semester One and Semester Two (Table 1). Perceived academic pressure in athletes fluctuated throughout the year, increasing to peak during two examination periods (e.g. June and October), followed by low academic pressure during the holidays (Figure 1). Academic pressure slowly increased during the academic teaching periods, starting off with low levels of academic pressure at the start of each semester, increasing to the highest levels of academic pressure at the end of each semester. There was no substantial difference between year groups for perceived academic pressure during Semester One, with first-year athletes averaging at 3.7 ± 1.00, and second-year and



third-year athletes both averaging at  $3.8 \pm 1.0$  (Table 1). However, there was a substantial difference during Semester Two between first-year athletes and third-year athletes with first-year athletes averaging  $4.0 \pm 0.9$ , and third-year athletes averaging  $3.6 \pm 0.9$  (Table 1). Similarly, third-year athletes had substantially more academic pressure in Semester Two compared to second-year athletes ( $3.8 \pm 0.8$  and  $3.6 \pm 0.9$  for the second-year and third-year athletes respectively).

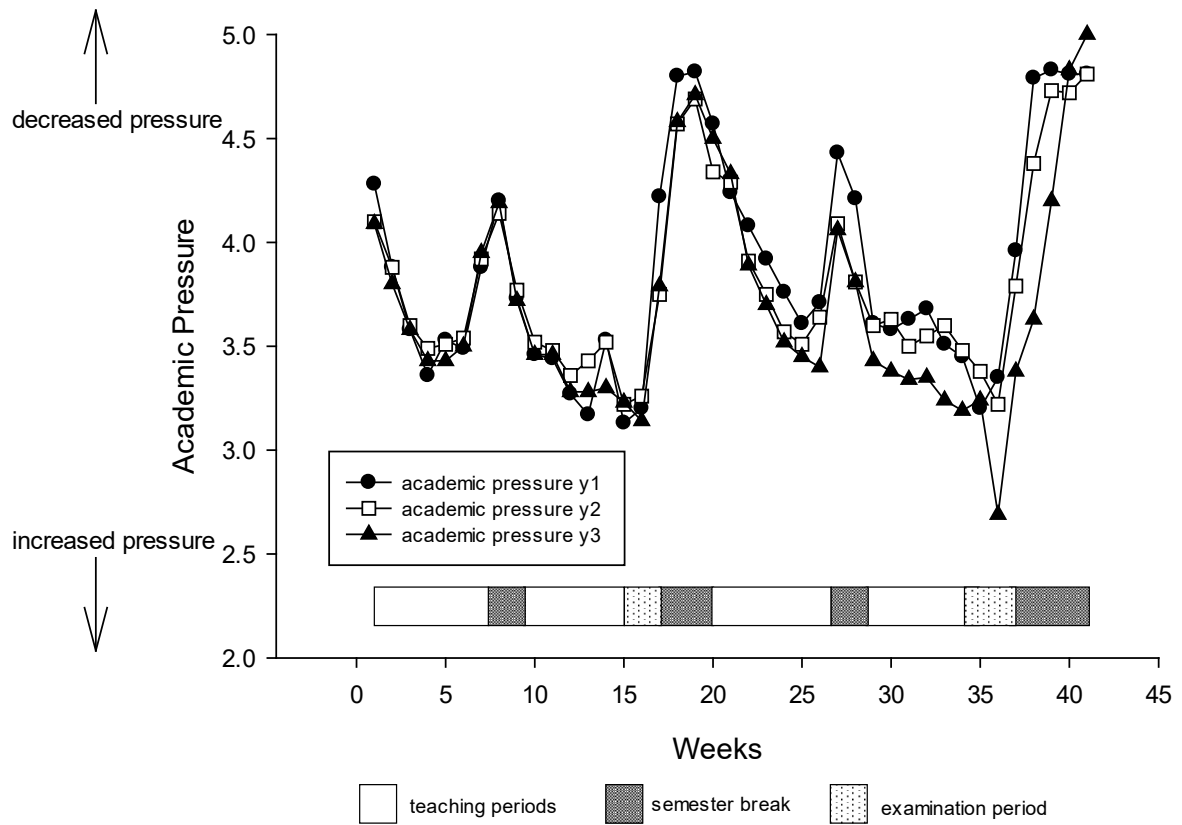


Figure 1. Mean Data for Academic Pressure between Different Year Levels throughout the Academic Year.

Perceived mood state for athletes remained somewhat the same throughout the year with first-year athletes, second-year athletes, and the first half of the year for third-year (Figure 2). All athletes had a similar mood state pattern throughout the year until approximately week 22, where third-year athletes perceived mood state began to decrease compared to first-year and second-year athletes, not increasing until after the second examination period. Second-year athletes reported slightly lower scores in perceived mood state than first-year athletes throughout the whole year, with first-year athletes reporting the highest scores of perceived mood state throughout Semester One and Semester Two. Perceived mood state in athletes during Semester Two reflected greater fluctuation than athletes in Semester One between all year levels, with third-year athletes scoring the lowest perceived mood state score for all year levels of 3.1 during week 35. Athletes in Semester Two also demonstrated substantial differences between first-year athletes and third-year athletes, with first-year athletes averaging at  $3.8 \pm 0.6$ , and third-year athletes averaging at  $3.6 \pm 0.7$  (Table 1).

Second-year athletes demonstrated substantial differences in perceived mood state to third-year athletes during Semester Two, with second-year athletes perceived mood state averaging at  $3.8 \pm 0.6$ , and third-year athlete's mood state averaging at  $3.6 \pm 0.7$  (Table 1). Week to week changes for all three years can be observed in Table 2 and demonstrate that there is variation in perceived mood state throughout the year for all year levels.

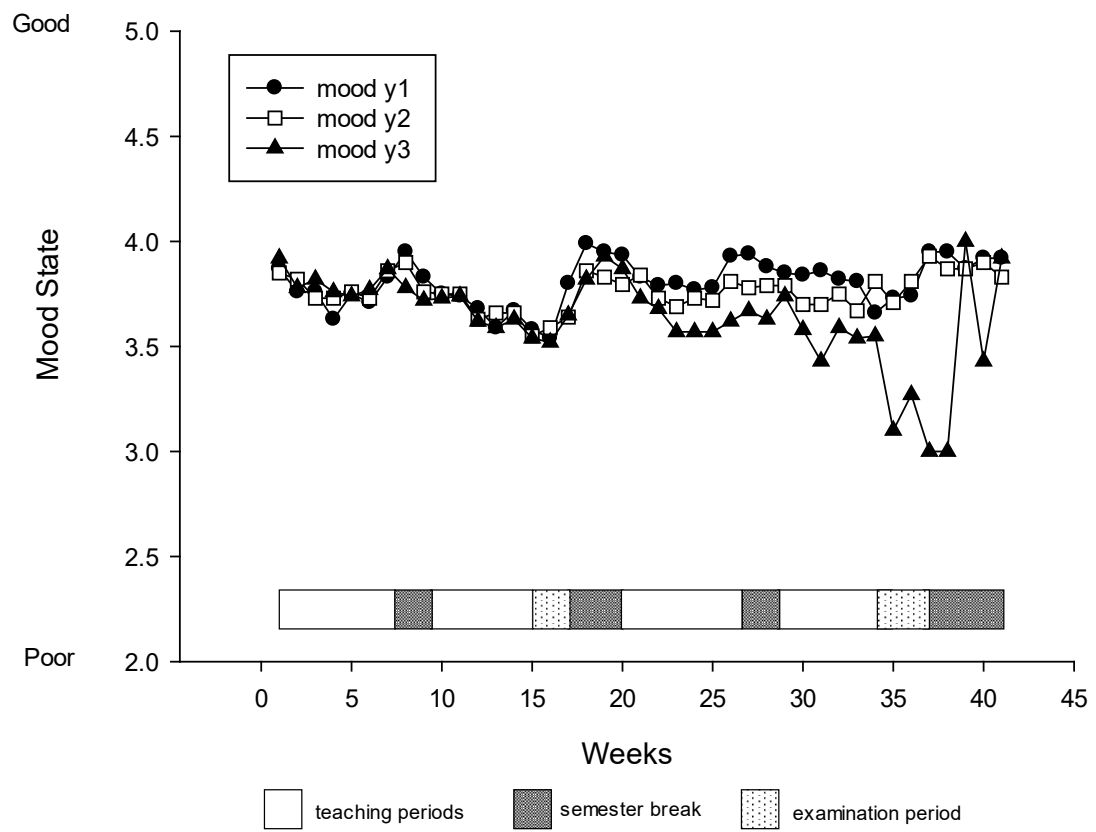


Figure 2. Mean Data for Mood State between Different Year Levels throughout the Academic Year.

Similar to perceived mood state, first-year athletes demonstrate the highest level of perceived sleep quality throughout the entire year, with third-year athletes demonstrating the lowest level of perceived sleep quality (Figure 3). Perceived sleep quality was highest when athletes were away from university and on their break. Third-year athletes reported a decreased level of perceived sleep quality, particularly towards the end of Semester Two. Substantial differences were found between first-year athletes and second-year athletes during Semester Two, with first-year athletes averaging at  $3.6 \pm 0.8$ , and third-year athletes averaging at  $3.4 \pm 0.8$ . (Table 1).

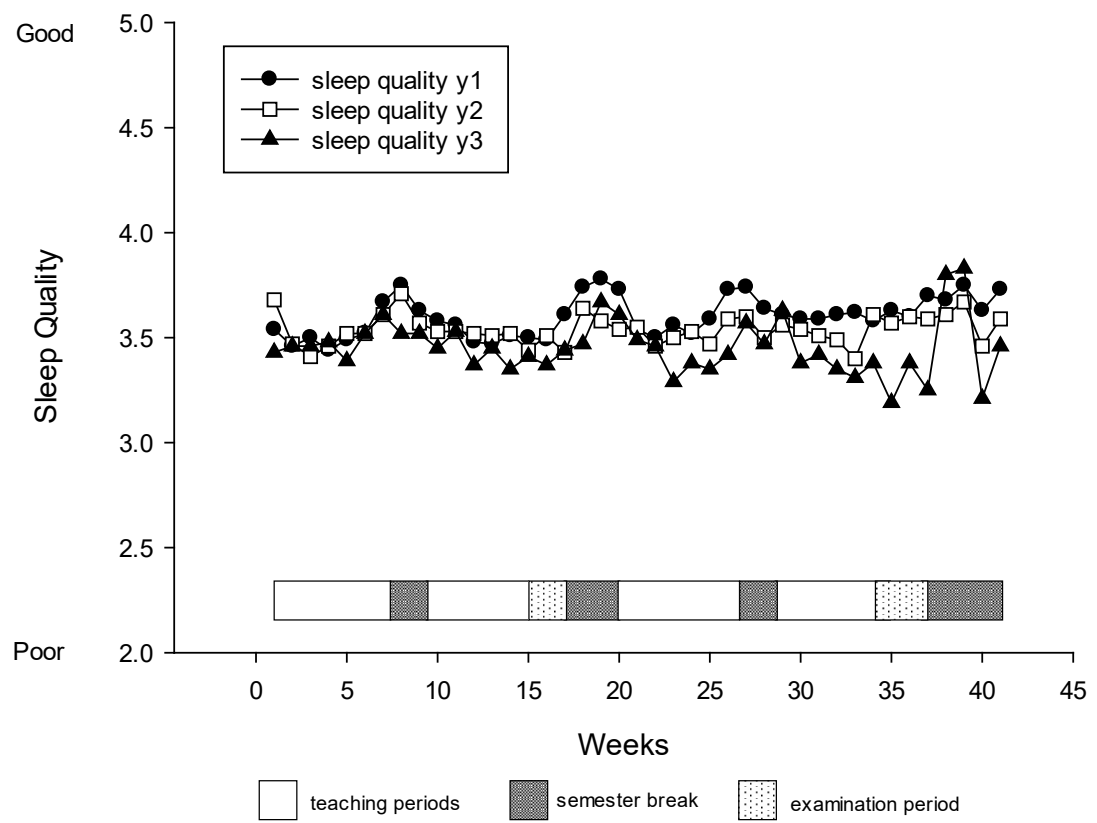


Figure 3. Mean Data for Sleep Quality between Different Year Levels throughout the Academic Year.

Perceived sleep duration for athletes over time is shown in Figure 4. First-year and second-year athletes show similar durations of sleep during both Semester One and Semester Two where their perceived sleep duration decreased during semester, and then increased during semester breaks. Third-year athletes reported substantially lower sleep duration throughout the entire year compared to other athletes with sleep duration as low as 6.79 hours during week 40. First-year athletes reported an average score of  $8.3 \pm 1.2$ , whilst third-year athletes averaged a score of  $7.9 \pm 1.3$  hours (Table 1) during Semester Two. Sleep duration for Semester Two also demonstrated a substantial difference between second-year athletes and third-year athletes, with second-year athletes averaging a score of  $8.2 \pm 1.1$  hours, and third-year athletes averaging a score of  $7.9 \pm 1.3$  hours (Table 1).

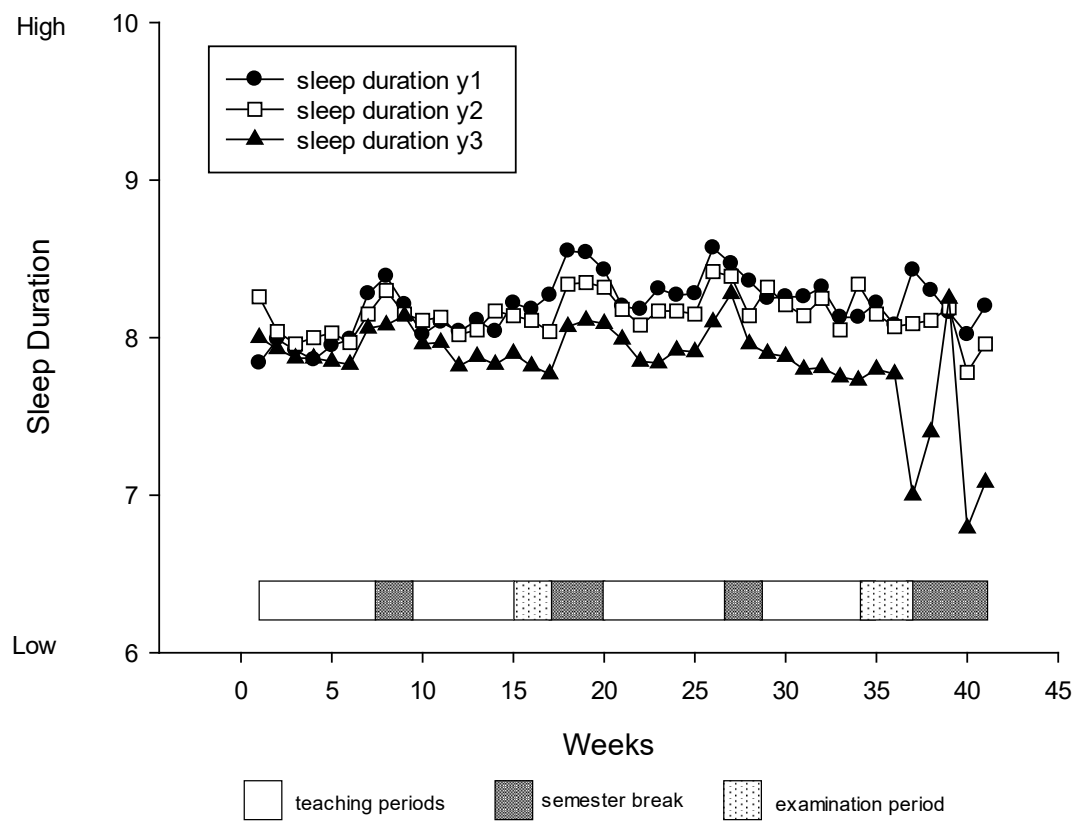


Figure 4. Mean Data for Sleep Duration between Different Year Levels throughout the Academic Year.



Perceived energy levels for athletes over time are shown in Figure 5. All year levels resembled a similar trend through Semester One with little fluctuation on their perceived energy levels during teaching time and breaks. It is important to note that there is a slight decrease in perceived energy levels when all year groups got back from their semester break and settled into teaching. During Semester Two, first-year and third-year athletes reported significantly different perceived energy levels, with first-year reporting an average score of  $3.7 \pm 0.6$ , and third-year reporting an average score of  $3.5 \pm 0.7$  (Table 1). The lowest reported score for perceived energy levels came from the third-year athletes, who recorded a perceived energy level score of 3 during week 38. Third-year athletes also reported the highest perceived energy level score of 4.08 during week 39 after the second examination period.

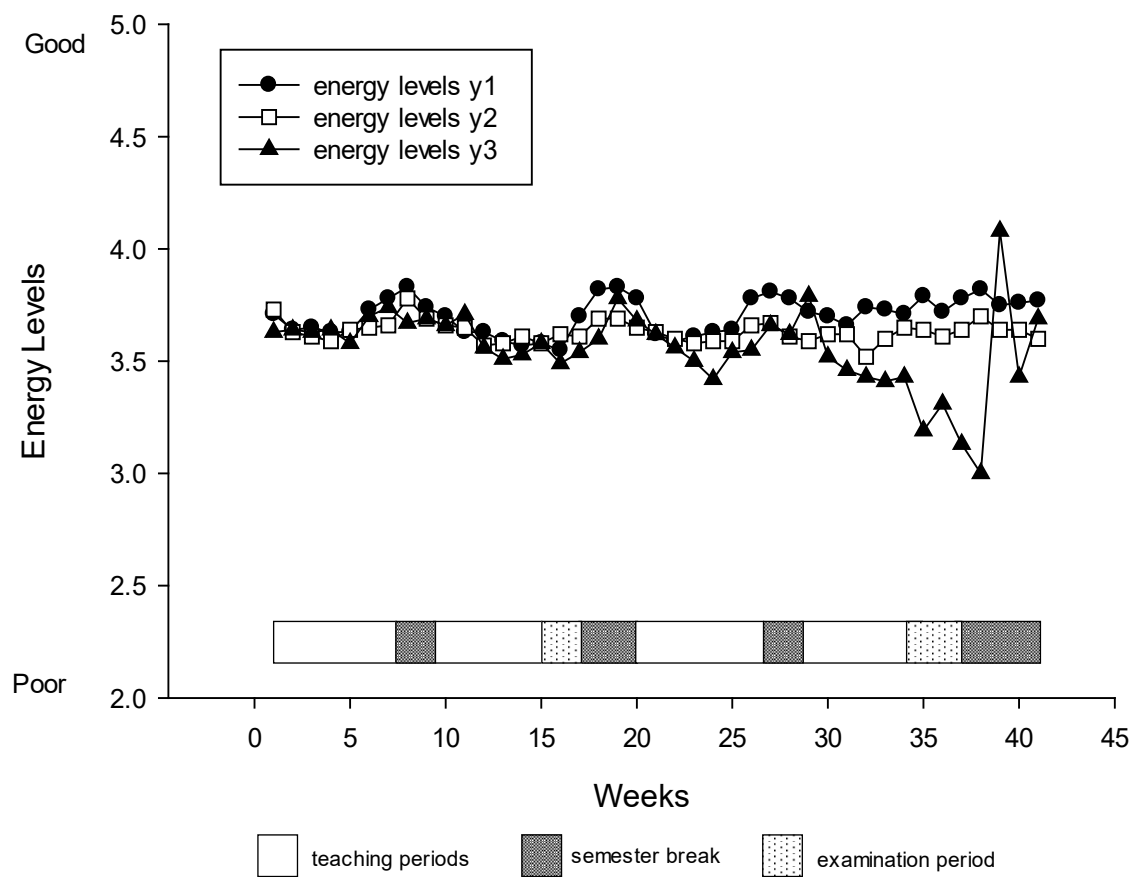


Figure 5. Mean Data for Energy Levels between Different Year Levels throughout the Academic Year.

Perceived muscle readiness for athletes over time is shown in Figure 6. Perceived muscle readiness demonstrated the least variation between and within all year levels. Second-year and third-year athletes reported lower results than first-year athletes during Semester One, with first-year athletes reporting an average score for muscle readiness of  $3.9 \pm 0.8$ , and second-year athletes reporting an average score of  $3.7 \pm 0.8$  (Table 1). Third-year athletes reported the lowest level of perceived muscle readiness during Semester Two directly after the second examination period with a score of 3.4 during week 38.

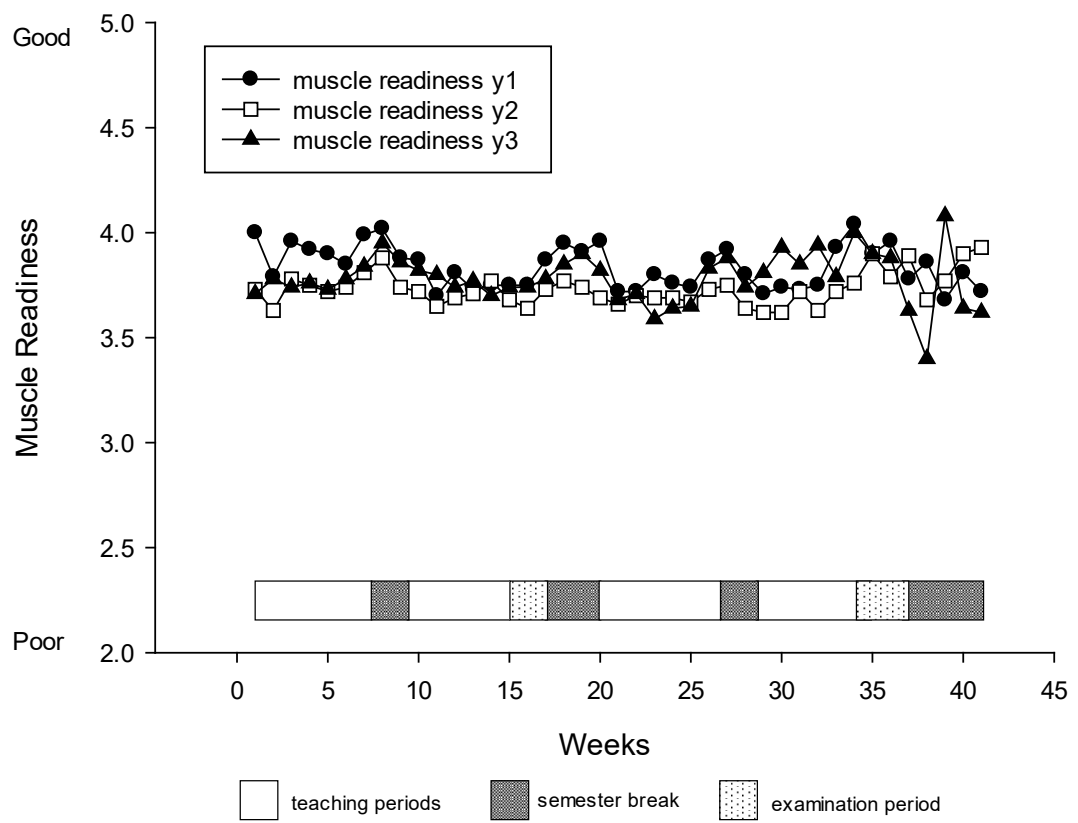


Figure 6. Mean Data for Muscle Readiness between Different Year Levels throughout the Academic Year.

Changes in weekly training volume (minutes) for athletes over the academic year are shown in Figure 7. Each year level demonstrated a different pattern throughout Semester One and Semester Two. Third-year athletes started the beginning of the year with the highest level of weekly training volume, before then dropping off to the lowest level of weekly training volume during the end of the year at the end of the second examination period. Second-year athletes peaked immediately before the first examination period, decreased suddenly, and then increased significantly after the second examination period. Substantial differences were not found between any year groups during Semester One but were found between groups during Semester Two. First-year and third-year athletes had substantial differences during Semester Two, with first-year averaging a weekly training volume score in minutes of  $273 \pm 192$  minutes, and third-year athletes averaging a weekly training volume score in minutes of  $214 \pm 144$  minutes. Second-year and third-year athletes also had substantial differences during Semester Two, with second-year athletes averaging a weekly training volume score in minutes of  $275 \pm 200$  minutes, and third-year averaging a weekly training volume score in minutes of  $214 \pm 144$  minutes (Table 1).

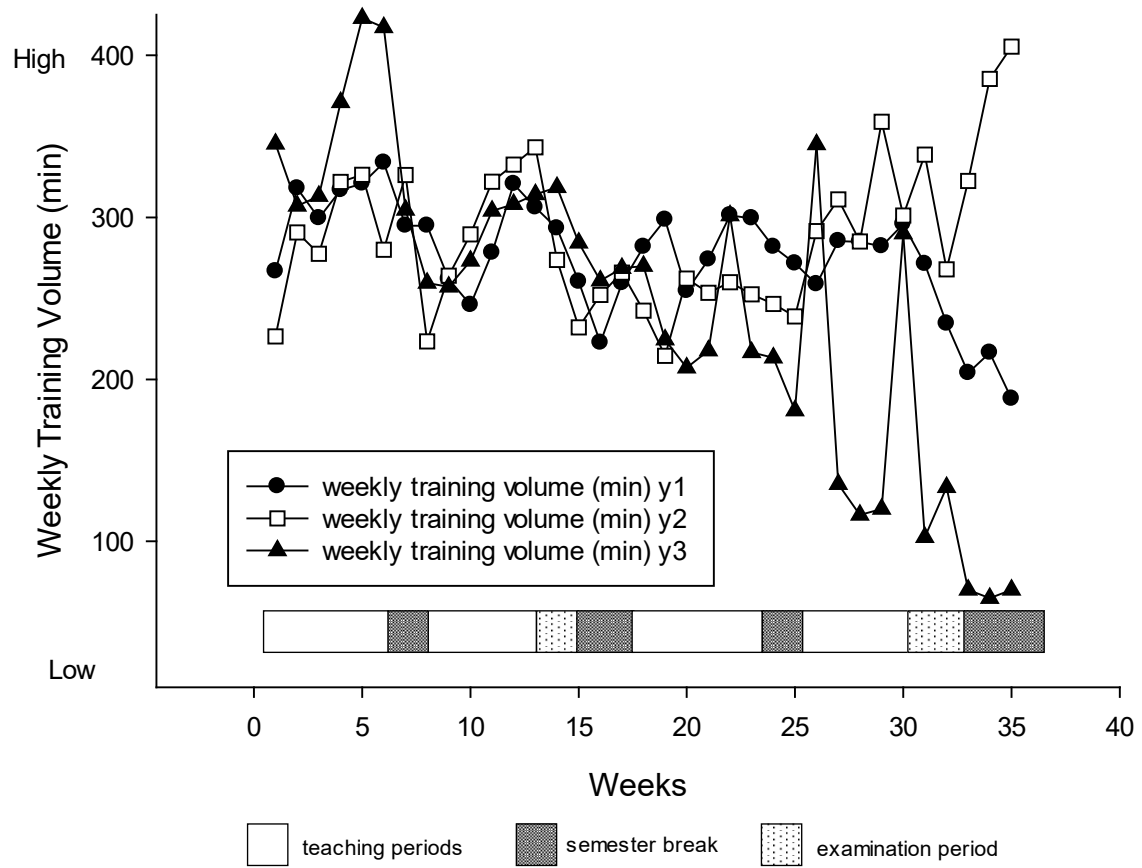


Figure 7. Mean Data for Weekly Training Volume between different Year Levels throughout the Academic Year.

Changes in weekly training load for athletes over time are shown in Figure 8. Weekly training load was broadly similar during Semester One, although there was a considerable variation between year levels with first-year athletes reporting an average weekly training load score of  $1591.5 \pm 1021.1$ , and third-year athletes reporting an average weekly training load score of  $1764.2 \pm 1345.7$  (Table 1). Further to this, second-year and third-year athletes also had substantial differences between each other during Semester One, with second-year athletes reporting an average weekly training load score of  $1600.7 \pm 1098.7$ , and third-year athletes reporting an average weekly training load score of  $1764.2 \pm 1345.7$  (Table 1). However, during Semester Two substantial differences occurred between first-year athletes and third-year athletes, with first-year athletes reporting an average weekly training load score of  $1498.1 \pm 1040.4$ , and third-year athletes reporting an average weekly training load score of  $1225.6 \pm 890.7$  (Table 1). Additional to this, second-year athletes and third-year athletes demonstrated substantial differences, with second-year athletes reporting an average weekly training load score of  $1492.9 \pm 1033.4$ , and third-year athletes reporting an average weekly training load score of  $1225.6 \pm 890.7$  (Table 1).

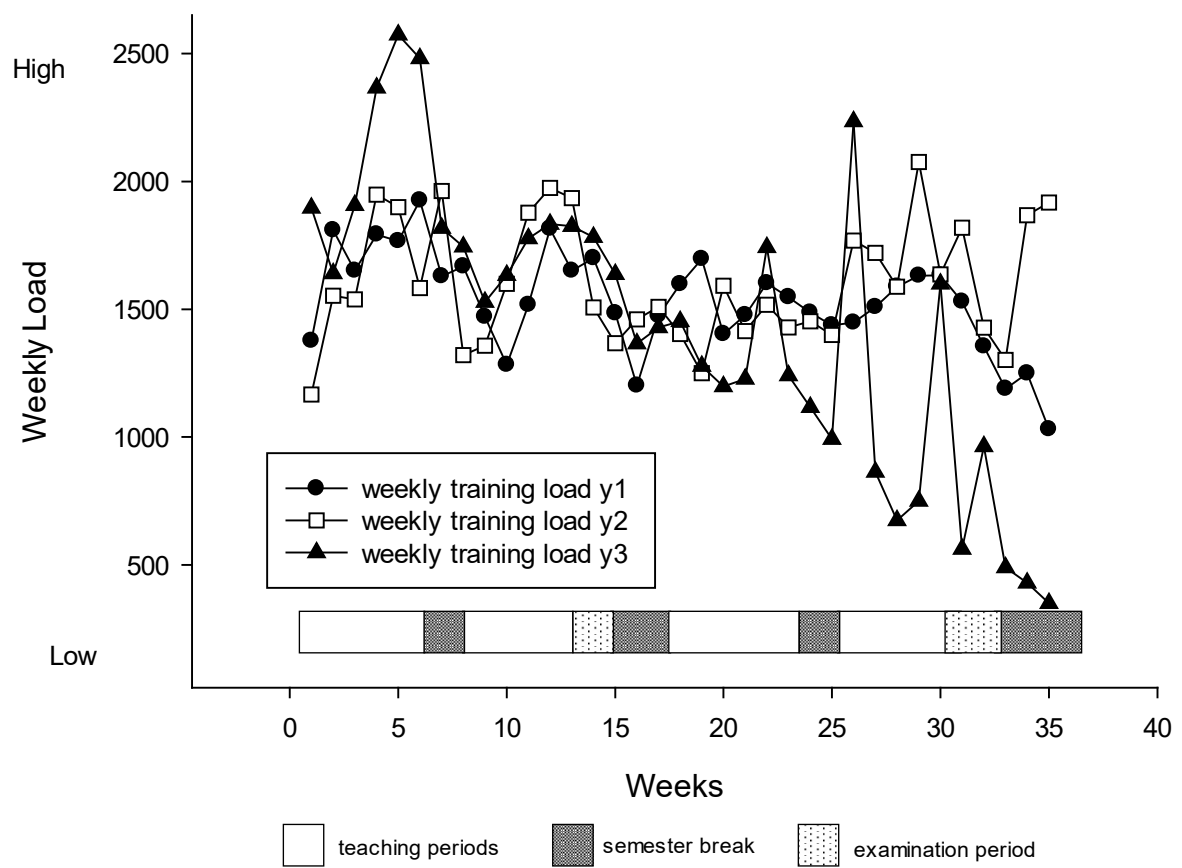


Figure 8. Mean Data for Weekly Training Load between Different Year Levels throughout the Academic Year.



## 4.2 Indications of stress and wellness; Female and Male Athletes

Table 2. Subjective Training Variables in each Semester over a 4-year Period; Female and Male Athletes.

Variable	Year 1		Year 2		Year 3	
	Sem 1	Sem 2	Sem 1	Sem 2	Sem 1	Sem 2
<b>Female</b>						
Mood	3.7 ± 0.7	3.7 ± 0.7 <sup>b</sup>	3.6 ± 0.7	3.7 ± 0.7	3.6 ± 0.7	3.4 ± 0.8 <sup>a</sup>
Energy	3.6 ± 0.7	3.6 ± 0.7	3.6 ± 0.7	3.5 ± 0.7	3.5 ± 0.7	3.3 ± 0.8 <sup>a</sup>
Sleep Quality	3.5 ± 0.8	3.5 ± 0.8	3.4 ± 0.8	3.4 ± 0.8	3.3 ± 0.9	3.2 ± 0.8 <sup>a</sup>
Sleep Duration	8.0 ± 1.3	8.0 ± 1.2	7.8 ± 1.3	7.9 ± 1.3	7.7 ± 1.3	7.7 ± 1.3
Muscle Readiness	3.9 ± 0.8	3.8 ± 0.8	3.8 ± 0.8	3.8 ± 0.7	3.8 ± 0.8	3.8 ± 0.9
Academic	3.7 ± 1.0	3.9 ± 0.8	3.7 ± 0.9	3.9 ± 0.8	3.7 ± 1.0	3.5 ± 1.0
Training Load	1661.9±1137.6	1626.7±1156.7	1617.7±1128.6	1426.7±939.2	1729.1±1377.6	1139.2±819.4
Training Volume (min)	293.3±184.9	292.1±211.1	283.3±194.8	244.7±165.3	275.9±222.5	196.0±121.8
<b>Male</b>						
Mood	3.8 ± 0.6	3.9 ± 0.6	3.8 ± 0.6	3.8 ± 0.6	3.8 ± 0.7	3.7 ± 0.7
Energy	3.7 ± 0.7	3.7 ± 0.6	3.7 ± 0.6	3.6 ± 0.7	3.7 ± 0.6	3.7 ± 0.6
Sleep Quality	3.6 ± 0.9	3.7 ± 0.8	3.6 ± 0.8	3.6 ± 0.8	3.5 ± 0.8	3.6 ± 0.8
Sleep Duration	8.2 ± 1.3	8.3 ± 1.2	8.2 ± 1.2	8.3 ± 1.0	8.0 ± 1.2	8.0 ± 1.2
Muscle Readiness	3.9 ± 0.8	3.8 ± 0.8	3.7 ± 0.8	3.7 ± 0.7	3.8 ± 0.7	3.7 ± 0.7
Academic	3.8 ± 1.0	4.0 ± 0.9	3.8 ± 0.9	3.8 ± 0.8	3.8 ± 1.0	3.7 ± 0.9
Training Load	1557.4±957.6	1449.2±988.2	1592.8±1084.5	1525.4±1075.4	1774.3±1336.6	1284.7±932.6
Training Volume (min)	282.5 ± 170.0	266.4 ± 184.6	278.5 ± 184.7	290.9 ± 214.1	312.2 ± 203.1	226.5 ± 157.2

Data is mean ± SD. Values are based on a 5-point Likert scale except for sleep duration which is hours, where 1 = poor, and 5 = very good for all variables except academic pressure where 1 = academic pressure a struggle, and 5 = no academic pressure. **aSubstantially different between female and male in year 3 semester 2, bSubstantially different between female and male in year 1 semester 2.**

There are substantial differences between female and male athletes during semester two of the academic year (Table 2), with third year female athletes scoring lower than third year male athletes in perceived energy levels, perceived mood state, and perceived sleep quality. Female athletes reported an average score of 3.3 ± 0.8 for energy levels, 3.4 ± 0.8 for mood state, and 3.2 ± 0.8 for sleep quality, all of which were lower than male athletes who reported an average score of 3.7 ± 0.6 for energy levels, 3.7 ± 0.7 for mood state, and 3.6 ± 0.8 for sleep quality during their last year at university in semester two (Table 2).

### 4.3 Indications of relationships between subjective variables using a correlation analysis

Table 3. Correlation Coefficient Analysis of Subjective Training Variables

Variable	Academic	Mood state	Sleep Quality	Sleep Duration	Energy Levels	Muscle Readiness	Weekly Volume	Weekly Load	RTT
Academic	-								
Mood state	0.32	-							
Sleep Quality	0.16	0.42	-						
Sleep Duration	0.13	0.20	0.43	-					
Energy Levels	0.20	0.46	0.50	0.27	-				
Muscle Readiness	0.15	0.22	0.20	0.07	0.33	-			
Weekly Volume	0.02	0.02	0.005	0.03	0.004	-0.07	-		
Weekly Load	-0.04	0.06	0.03	-0.01	-0.03	-0.12	0.90	-	
RTT	0.51	0.68	0.70	0.37	0.78	0.40	-0.00	-0.03	-

A correlation coefficient analysis was carried out to investigate the relationship between perceived academic pressure and subjective variables to measure what variables might influence an athlete's level of perceived academic pressure (Table 3). Results show that the strongest subjective variable influencing perceived academic pressure was RTT, with a correlation of 0.51. The second strongest correlation to perceived academic pressure was perceived mood state, with a correlation of 0.32 (Table 3). Although the focus was on perceived academic pressure, results also show a substantially strong correlation between weekly load and weekly volume, with a near perfect correlation of 0.90 (Table 3).

A step-wise regression analysis was carried out to investigate how variables might interact with perceived academic pressure. This analysis would help to give a better understanding on what the athletes are experiencing, and how to better support their academic needs. The strongest variables associated with perceived academic pressure consisted of the combination of RTT, perceived sleep quality, and perceived energy level, with an  $r^2$  value of 0.4264, or an  $r$  of 0.65. The linear regression formula is Academic Stress =  $2.33 + (-0.4871 \times \text{Sleep Quality}) + (-0.5988 \times \text{Energy Levels}) + (8.0269 \times \text{Ready To Train Score})$ . The step wise regression equation was taken to the third step to give an  $r^2$  of 0.4264 as other variables such as perceived muscle readiness, perceived mood state, sleep duration, weekly volume, and weekly load beyond this (step 4-9) only changed the  $r^2$  very minimally.

When correlating athletes perceived performance (how did I do score) with other psychological variables, we found only weak relationships with mood state ( $r=0.16$ ) and sleep quality ( $r=0.15$ ). When correlating athletes perceived performance (how did I do score) with other physiological variables, we found only weak relationships with weekly training load ( $r=0.12$ ).

## 5.0 DISCUSSION

The rationale for undertaking this research concerns the need for understanding the wellness and stress of elite athletes completing full-time tertiary studies, and to identify in which stages athletes are more vulnerable to psychological and physical stress. This would allow for a greater understanding of the pressures that athletes and students experience, increasing the knowledge that academic staff, coaches, and managers can directly apply to protect athletes as much as possible from any harm or unwanted consequences of training. This research highlights certain times in the academic year where athletes are likely to be influenced by increased psychological stress, which is reflected in their subjective measures of mood state, sleep quality and sleep duration, energy levels, weekly training load, weekly training volume, and academic pressure. These pressure points coincide with examination periods when athletes must pass their courses and perform well in their sports. Exam periods are a time when university students commonly feel restricted in their freedom, doubt their capabilities, and have limited social interactions due to the high academic pressure and demands. This data shows that female athletes experience and respond to stress differently than male athletes; that third-year athletes experience greater stress compared to first-year and second-year athletes; and that certain subjective measures are strongly associated with academic pressure.

### 5.1 Major Findings

#### 5.1.1 Differences in Year Groups

A substantial outcome of this study relates to the differences between first year, second year, and third year athletes. As demonstrated in Table 1, year groups experience pressures differently throughout the academic year. We found that once sport scholars started at university at the beginning of the year, they were not highly stressed. As the semester began, pressures and distress began to increase leading up to exams, and the athlete's coping ability was tested. The work of Zunhammer et al., (2013) outlined a minor increase in bodily complaints during exam period for university students, including gastrointestinal and autonomic symptoms, back pain, abdominal pain and nausea. However, the

symptoms with the highest increases during exam periods were loss of appetite, frequent diarrhoea, anxiety, worry, tiredness, and headaches (Zunhammer et al., 2013). These physical and psychological symptoms can clearly identify specific areas to target for improving the coping of stress for certain students. With psychological measures deteriorating during the semester (immediately before and during exams), some athletes show a greater need for coping with stress around exam time. Previous research indicates students report academic pressure as a major trigger for stress during their time at university (Galante, Dufour, Vainre, Wagner, Stochl, Croudace, Benton, Howarth, and Jones, 2017). These findings demonstrate relevance to this current study with academic pressure being the psychological measure that fluctuates the most throughout the academic year, which may be a useful tool for monitoring and managing academic pressure in athletes.

We found that sports scholars undergo a rhythmical cycle of psychological stress around examination time, in which academic pressure increases during the week of exams, and then decreases directly after exams. Academic pressure can lead to negative emotions such as fear, anxiety, and worry (Zhang and Zheng, 2017), all of which are associated with distress. These negative emotions can impact other areas of an athlete's life, such as their sport performance. This rhythmical cycle of psychological stress is also reflected through subjective measures such as sleep quality, sleep duration, energy levels, and mood state, where these measures worsen during academically demanding times of the academic year and become better during holidays.

Acute stress could be beneficial for athletes during exams because it forces them to focus and teaches them how to manage short term stressors (Symonds, 2009), however high stress over a lengthy period could prove detrimental. This is because the perceived ability to cope with a traumatic and/or resource demanding event (e.g., exams and prolonged stress from academic pressure) has been shown to affect psychological outcomes (Bosmans and Van der Velden, 2017). Therefore, there needs to be interventions put in place for university students as well as sport scholars who are likely to experience more stress due to their increase demands. Stress represents a deviation from a homeostatic norm and can be influenced by the relationship between an individual and the environment where stress exceeds resources (Lazarus et al., 1984). Sport scholars are sometimes under-prepared, normally receiving lower grades than their non-athlete peers because of their need to execute two cognitively demanding roles on a daily bases for a long period of time (Symonds,

2009). Previous research has suggested that university can be a turbulent time where students undergo developmental challenges that can be complicated by the stressors of university and sport commitments (Ahern and Norris, 2011). These findings demonstrate times in the year when stress levels are higher than normal, which may cause unwanted stress build-up, resulting in an increased demand to engage coping mechanisms for stress. Therefore, there may be a need for greater support for some athletes at these high stress times of the academic year.

First-year, second-year, and third-year athletes experience different levels of pressures and stress in relation to certain subjective measures. For example, third year athletes demonstrate substantially decreased levels of wellness including mood state, energy levels, sleep quality and sleep duration than first-year and second year athletes during both semester one and semester two (Table 1). Third-year athletes also demonstrate substantially higher levels of pressure (academic pressure, weekly training load and weekly training volume) than first-year and second-year athletes during both Semester One and Semester Two (Table 1). These findings could be due to the greater pressure that third-year athletes experience during their final year of their degree and their scholarship programme. As athletes carry out their third year at university, although they may have had time to adjust to the demands and expectations of their studies and their sport, greater focus is expected on completing their degree, looking into career opportunities, and representing national and international sports clubs and teams. Despite these suggestions, there is limited research associated around different pressures for first-year, second-year, and third-year students at university. We suggest that the combination of these pressures can result in higher stress for sport scholars, as well as higher stress for third-year athletes than first-year and second-year athletes.

#### 5.1.2 Differences in perceived academic pressure

Of the eight main subjective and training variables used in this study, perceived academic pressure appeared to vary the most throughout the year for all year groups (Figure 1). This finding could be due to the continually demanding pressure that students experience with their studies where they are required to maintain suitable grades to complete their degree, as well as manage examinations, deadlines, and increased workloads. There is added pressure for sport scholars, if they don't pass their courses, they will be removed from the

scholarship programme. There is empirical evidence which indicates that increased stress can have a detrimental impact on the academic performance of university students, with previous research showing that stress is the most important factor influencing academic performance (Chow, 2007). Time management issues and low grades are in the top 5 stressors that university student's face (Negga, Applewhite, and Livingston, 2007). Previous studies suggest that academic stressors occur for a student when there is inadequate time to increase the student's present knowledge base, which can be overcome through regular use of effective coping mechanisms (Misra and McKean, 2000).

Academic pressures can also lead to performance decrements and physical problems (Andersen and Williams, 1988), with previous research finding that stressors such as tests and papers are positively correlated to the occurrence of illness for university students, including anxiety and depression (Aldwin and Greenberger, 1987; Lesko and Summerfield, 1989). Sport scholars have to deal with the normal academic workloads, but they also have training (which may be up to 4 times per week), competition (usually 1-2 times per week), recovery sessions, injury problems, as well as selection stressors associated with sports teams, increasing the need for greater time management. Illness levels were halved in athletes that completed stress-management training (Perna et al., 2003), which can prove helpful to the psychology of an athlete. This may be a useful intervention strategy for the sport scholarship programme for those athletes that may be susceptible to high stress loads.

### 5.1.3 Differences in female and male athletes

This study aimed to use a large population group to either verify or contradict Leeder et al., (2012) findings, which suggested that females have better sleep quality than males of the same age. We found that female athletes appear to demonstrate substantially decreased levels of sleep quality with an average score of  $3.2 \pm 0.8$  compared to male scores of  $3.6 \pm 0.8$  (Table 2). Previous research indicates that sleep difficulties are common amongst university students, with sleep quality deteriorating during times when university students experience an increase in academic demands and stress (e.g., exam periods) (Campbell, Soenens, Beyer, and Vansteenkiste, 2018). We also found that other psychological measures affect female and male athletes differently. Based on the results of this study, female athletes appear to demonstrate sustainably decreased energy levels with an average score of  $3.3 \pm 0.8$  compared to male athlete scores of  $3.7 \pm 0.6$  during Semester Two, as well as substantially decreased

levels of mood state with an average score of  $3.4 \pm 0.8$  compared to male athletes of  $3.7 \pm 0.7$  during Semester Two. It has been postulated that females actually require greater amounts of energy to allow for normal menstrual function in addition to energy expenditure for performance (Birch et al., 1999). It also appears that for female athletes, the reproductive system is more affected than for male athletes with training (Birch et al., 1999). This could be why the energy levels were lower in female athletes because of the increased demand of the female body for resources to maintain enough energy for normal menstruation and training.

Decreased energy levels, mood state, and sleep quality in female athletes are reflected in the results of this study, demonstrating that female and male athletes experience and record stress differently. These results suggest that female athletes may have different psychological demands during Semester Two of their first-year, which may be helped with suitable gender-specific interventions

#### 5.1.4 Correlations of subjective training variables

A correlational analysis was carried out to see which subjective measures were related to perceived academic pressure in an attempt to help reduce the academic pressure for sport scholars during their time at university. The strongest single variable associated with perceived academic pressure was perceived mood state with a moderate correlation of 0.30. It is known that mood state can be affected by exercise, where moderate training is associated with a positive mood state (Selmi et al., 2018), yet there is currently limited research between mood state and academic pressure for university students. Based on this current study, it can be demonstrated that as academic pressure gets worse, mood state also gets worse, and that as academic pressure improves, mood state also improves. These findings may be due to the emotional connection that athletes might have with stress from tests, presentations, and exams. As athletes get closer to the examination periods during the academic year, mood state deteriorates for all year levels, and then improves after the exam period is over. Mood and emotions negatively affect logical reasoning and performance outcomes (Jung, Wranke, Hamburger, and Knauff, 2014). Emotions are proven to also have an impact on how an athlete thinks, what they decide, and how they solve problems (Jung et al., 2014). This suggests that as an athlete's mood state lowers, their ability to solve problems (e.g., texts and exams at university) becomes impacted, reflecting what we found in this current study with mood and academic pressure interacting with each other for an athlete.



Jung et al. (2014) findings suggest that as an individual's emotional state deteriorates, their attention, motivation, and performance also deteriorates (Jung et al., 2014).

There was also a moderate to strong association between academic pressure and RTT (0.51). This finding demonstrates the likelihood of high levels of academic pressure having a negative impact on other factors of wellness, including those that make up the RTT score. The RTT is an aggregated score for measuring the psychological wellness of an athlete, with this study demonstrating stronger findings between an aggregated score such as RTT than with an individual score such as academic pressure or energy levels. Certain researchers have focused primarily on single psychological variables (Roky et al., 2012 and Netz et al., 2002) to explain changes in physical performance, demonstrating that incorporating various psychological variables to explain an athlete's wellbeing is relatively unique. Focusing on the relationship between two variables allows for specific incremental findings that can be directly applied to athletes. However, incorporating a variety of variables to predict an athlete's psychological wellbeing through an aggregated score can provide a wide overview of variables that influence an athlete's overall wellbeing. Sport scientists may choose to use an aggregated score to better gauge an athlete's overall wellbeing, which may be worthwhile, yet using an individual score to measure an athlete's wellbeing has also proven to be effective (Kellmann, 2010; Roky et al, 2012; & Netz et al, 2003).

A further moderate to strong correlation was found between sleep quality and sleep duration (0.43), demonstrating a relationship between sleep measures. This was something the researcher expected to find, reflecting what is already discovered in the literature (Leeder et al, 2012; Reilly et al, 1983; Lastella et al, 2015; & Sargent et al, 2014).

To find out whether there were certain measures that combined together to influence an athlete's academic pressure, a step wise regression analysis was carried out. An  $r$  value of 0.66 was found when we combined mood state, sleep quality, energy levels, muscle readiness, and RTT. This result suggests that an athlete's academic pressure is related to a combination of variables. Subjective measures such as academic pressure, energy levels, mood state, muscle readiness, sleep quality and sleep duration do not function in isolation, but instead are substantially impacted by one another. This provides worthwhile information for academic staff, athletes, coaches, and managers to gain a strong understanding of the psychological wellbeing of athletes.

#### 5.1.5 Subjective performance score

After each training session an athlete was asked to record their performance based on a “how did I do?” score using a 1-5 Likert-type scale, where 1 represents poor, and 5 represents good. This study looked at the relationship between an athlete’s “how did I do?” score to other subjective and training measures, finding that there were no statistically strong relationships between the variables. These results suggest that the “how did I do?” measure has no strong relationship to the variables measured (academic pressure, energy levels, mood state, muscle readiness, sleep duration, sleep quality, weekly training load, and weekly training volume). Further research needs to be undertaken to analyse the intention and use of the “how did I do?” score for Lincoln University sport scholars.

## 6.0 LIMITATIONS

This study was dependent on sport scholars logging self-reported data on their subjective and training information, where there was full dependence on them submitting honest entries. Each day the athlete would record their subjective measures alongside their training measures, where most of the measures required numerical entries. Despite athletes being briefed and trained on how to load their entries, there is still a chance that some athletes may have distorted information, either intentionally or unintentionally, resulting in incorrect data. Athletes may not have wanted to continuously log their daily entries, potentially resulting in inaccurate entries. Incorrect entries mean that the results from this study may not accurately reflect how female and male first-year, second-year, and third-year athletes experience stress at university.

There is a drop-off in data entries for third-year athletes, which may have led to the large variation in the third-year athlete's values. Therefore, the results of this study that involve third-year sport scholar's data needs to be taken as suggestive until it can be substantiated with more research with higher subject numbers.

### 6.1 Recommendations for Future Research

This research has revealed various gaps in contemporary research relating to monitoring athlete's and has highlighted the need for future research in this area. Scientists should find out the results behind the differences between female and male athletes. This should involve both analysing subjective measures over a period, and the biology and behaviour of female and male athletes. This may provide more information on why the difference occurs. Additional to this, future research should look at applying interventions to assist in supporting some of the third-year sport scholars and female scholars.

The replication of this study with slight modifications to the sample and methodology is recommended. Replicating this study with greater involvement from third-year athletes would substantially improve the generalisability of this research to all athletes and university students. Furthermore, when conducting such a study, asking athletes specific questions on their subjective wellbeing and their training through qualitative and quantitative questions would provide extra detail around the associations that this research has uncovered. It would

be beneficial to ask individual athletes what motivates them to want to contribute to inputting their data correctly so that participation can be maximised.

Considering other elements of an athlete's wellbeing through spirituality and religiosity measures might need to be considered for future research. This type of research may only prove beneficial to some athlete's and not all, however, it is still worth analysing. Spirituality and religiosity have been beneficial to health and psychological wellbeing (George, Larson, Koenig, and, McCullough, 2000). Psychological wellbeing has been found to be positively influenced by spiritual beliefs, and the stronger the spiritual beliefs, the stronger the psychological well-being (Kashdan and Nezlek, 2012). Further to this, spiritual goals have been reported to generate a greater sense of meaning in life and life satisfaction, and lower levels of stress (Kashdan et al., 2012), all of which may prove beneficial to athletes and their wellbeing. Potentially incorporating future research around spirituality and religiosity may assist in greater awareness and coping mechanisms, resulting in potential improvement of an athlete's wellbeing.

## 6.2 Implications of this Research

Knowing that athletes suffer greater pressure at certain times of the academic year may help coaches to put interventions in place to help the athletes cope and/or relieve their stress. As identified by ACHA, university students with high levels of stress also record high levels of sleep difficulties, depression and anxiety, feelings of hopelessness, exhaustion, and being overwhelmed during their studies, with some students even considering suicide (American College Health Association, 2009). The findings of this research indicate that during exam periods of the academic year, some athletes experience increased levels of stress and decreased levels of wellness.

During exams, sport scholars report increased levels of academic pressure, decreased levels of sleep quality, sleep duration, mood state, and energy levels, as well as increased levels of training for third year athletes. These findings can be communicated to sport staff and university staff to increase the support during these pressuring times. A practical application from these findings could include more social activities, mindfulness workshops, and opportunities to learn more about managing stress during exams. The use of mindfulness interventions has gained increasing interest for reducing stress, injury reduction, and improving wellbeing for sport professionals (Petterson and Olson, 2017). Petterson and Olson

(2017) describe mindfulness as “a state of mind associated with non-judgmental open-minded acceptance of all thoughts and emotions.” Interventions that are focused on cognitive and behavioural principles demonstrate reduced stress and burnout (Clough et al., 2017).

This research has provided valuable information on third-year athletes who have substantially lower levels of wellness (mood state, energy levels, sleep quality, and sleep duration), as well as higher levels of pressure (academic pressure, weekly load, and weekly volume). Applying possible interventions or changes in protocols and management to third-year sport scholars might allow for reduced stress, resulting in greater wellness and sport performance.

This research has also found energy levels, mood state, and sleep quality are all lower in female athletes, demonstrating a need for different support levels between females and males. Learnings from these findings can be applied directly by coaches and managers involved in their sports to ensure that female athletes are getting enough recovery to reboot their energy levels and sleep. This research has not only recognised the association of academic pressure on an athlete’s wellbeing, it has also alerted us to the idea that academic pressure is associated with mood state and RTT, where psychological measures such as energy levels, mood state, and sleep quality are influenced by academic pressure. Knowing this will allow for sport and university support to focus more on helping students at the beginning of their university year to better prepare for the increased times of pressure.

Gaining an appreciation of the need that sport scholars have with their wellbeing will assist in creating strategies, policy and interventions that cater to managing stress, improving wellbeing and quality of life for a growing population of sport scholars, and in turn, may result in improved performance for athletes on the sport field and in the classroom. Examples of strategies and interventions may include workshops focused on psychological wellbeing and stress for athletes to attend during each semester of the year, where theory and practical elements can be applied.

Training athletes on keeping gratitude diaries could help in supporting them to a greater level. The “classic” gratitude intervention involves writing lists of several things for which one is grateful on a regular basis. Wood et al. (2010) alludes to the idea that gratitude confers resilience, which may assist in better support for our sport scholars when they are

exposed to demanding pressures in their sport and study (Wood et al., 2010). Krejtz et al. (2016) suggests that “counting one’s blessing” can reduce the negative effects of daily stress, resulting in positive long-term effects on mental health (Krejtz et al., 2016). Challenges such as interactive quizzes could also be incorporated into an athlete’s academic curriculum where they are asked to learn more about coping strategies. This could lead to a compulsory course for athletes to attend in their first-year of university where they learn about stress and coping.

### 6.3 Research Objectives Addressed

The four predominant research objectives explored in this study were:

1. To analyse indicators of stress and wellness between first-year, second-year, and third-year athletes: measured through perceived academic pressure, perceived energy levels, perceived muscle readiness, perceived mood state, perceived sleep quality, perceived sleep duration, weekly training load, and weekly training volume
2. To analyse indicators of stress and wellness between female and male athletes: measured through perceived academic pressure, perceived energy levels, perceived muscle readiness, perceived mood state, perceived sleep quality, perceived sleep duration, weekly training load, and weekly training volume
3. To analyse the main measures that are related to or associated with academic pressure. The variables that are of interest are; readiness to train (RTT), perceived muscle readiness, weekly training load, weekly training volume, perceived energy levels, perceived mood state, sleep duration, and perceived sleep quality
4. To investigate relationships between the athletes perceived athletic performance and measures of training and psychological stress. The variables that are of interest are; weekly training load, weekly training volume, sleep quality, sleep duration, perceived academic pressure, perceived energy levels, perceived mood state, and perceived muscle readiness

Regarding research objective one, first-year athletes, second-year athletes, and third-year athletes show a similar pattern of stress during the academic year, but when analysing

individual subjective measures, each year level was subtly different. Third-year athlete's demonstrated increased levels academic pressure, weekly training load, and weekly training volume, as well as decreased levels of wellness through factors such as mood state, energy levels, sleep quality, and sleep duration. The second and third research objectives were also answered through this research where female athletes recorded lower scores of energy levels, mood state, and sleep quality compared to male athletes. The third research objective was answered through this current study, providing results that certain subjective measures carry strong relationships to each other, with RTT exhibiting strong correlations to subjective measures such as academic pressure, mood state, sleep quality, sleep duration, energy levels, and muscle readiness. Other measures such as sleep duration and sleep quality, as well as weekly training load and weekly training volume were strongly correlated as well. The fourth research objective was answered with weak findings, with the "how did I do?" score being weakly related to mood state, sleep quality, and weekly training load.

## 7.0 CONCLUSION

The use of monitoring sport scholars during their time at university has been the focus of this study. Previous research has not managed to monitor such a large population of athlete's involved in full-time study over such a long period. This study has demonstrated specific times throughout the academic year where there is increased academic pressure and decreased levels of wellness (including factors such as academic pressure, energy levels, mood state, muscle readiness, sleep duration, sleep quality, weekly training load, and weekly training volume). Female and third-year athletes are more vulnerable to this change during exam periods. Additional findings from this study demonstrated that perceived academic pressure is associated with other psychological measures, such as mood state, sleep quality, and energy levels.

This study highlights the importance for monitoring athletes to improve their performance and wellness throughout their time at university, and to provide interventions to be carried out by sport and academic staff/support for female and male athletes, first-year, second-year, and third-year athletes. Specifically, this study brings attention to the need to better monitor and support a growing population of sport scholars during exam times in the academic year, and to provide greater support to third-year sport scholars with their increased levels of stress and decreased levels of wellness.

Research is now required to determine the reason why there are differences between female and male athletes, as well as the need to put interventions into place to measure the effectiveness on athlete's stress and wellbeing. The implementation of interventions for these athletes is of paramount importance. It is essential that research relating to monitoring athletes continues, especially as this population continues to grow.



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## 9.0 APPENDICES

Appendix A: Summary of Questions for Athletes to Answer Daily

Appendix B: Metrifit Hints and Tips for Athletes (Introduction Session)



Summary of Questions for Athletes to Answer Daily:

1. Sport – respond with what sport they are involved in
2. Sex – respond with whether they are female or male
3. Scholarship year – respond with what year they start their scholarship programme
4. Mood state – respond with a Likert scale from 1-5, 1=very stressed, 2=quite stressed, 3=slightly stressed, 4=good, 5=very good
5. Sleep Quality – respond with a Likert scale from 1-5, 1= poor, 2=below average, 3=normal, 4=good, 5=very good
6. Sleep Duration – respond with a figure based on the hours spent sleeping
7. Energy Levels – respond with a Likert scale form 1-5, 1=extremely low, 2=very low, 3=low, 4=normal, 5=excellent
8. Muscle Readiness – respond with a Likert scale from 1-5, 1=extremely sore, 2=very sore, 3=quite sore, 4=mild soreness, 5=not sore at all
9. Diet Yesterday – respond with a Likert scale from 1-5, 1= poor, 2=below average, 3=normal, 4=good, 5=very good
10. Academic Pressure – respond with a Likert scale from 1-5, 1=academic time management a struggle, 2=academic pressure building, 3=heavy academic day, 4=normal academic workload, 5=no academic pressures
11. Health – respond with a Likert scale from 1-5, 1= poor, 2=below average, 3=normal, 4=good, 5=very good
12. Body Locations – respond to pop up check boxes that appear if the participants scores below a certain value (usually 2 or 3) on a particular slider. It allows them to give more information about issues – for muscle soreness for example they might tick check boxes which indicate which body parts are sore
13. Readiness to train score (RTT) – a collective measure based on mood state, sleep quality, energy levels, muscle readiness, diet yesterday, and academic pressure to gather a percentage
14. Training type – respond with general comments such as ‘strength/power’, ‘recovery’, or ‘sport specific’
15. Duration trained – respond with a written number of how long the participant trained for in one session
16. Rate of perceived exertion (RPE) – respond with a Likert scale from 1-10, 1=very light, 2=fairly light, 3=moderate, 4=somewhat hard, 5=hard, 6=hard, 7=very hard, 8=very hard, 9=very hard, 10=very very hard
17. How did I do score – respond with a Likert scale, 1= poor, 2=below average, 3=normal, 4=good, 5=very good

## Appendix B

### Metrifit Hints and Tips for Athletes (Introduction Session)



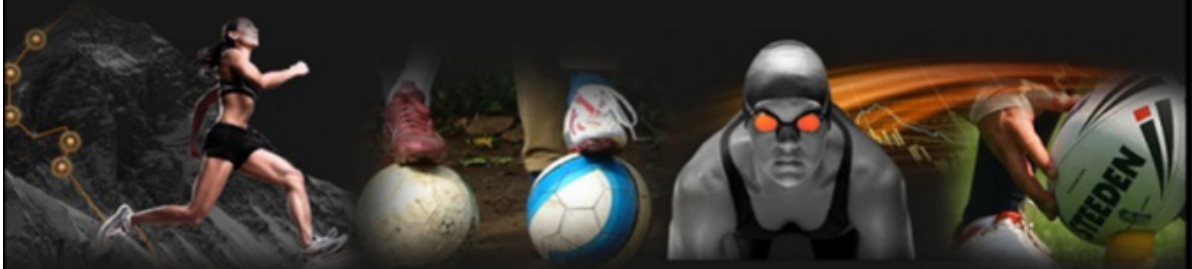
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linking practice to performance

## Hints & Tips for Metrifit Use



## Hints & Tips for Metrifit Use

- ✓ Security – Make sure you change your password
- ✓ Settings/Profile
- ✓ Logging Body & Mind/Readiness to Train
- ✓ Logging Injury (typically this will be done by Medical staff)
- ✓ Logging Training
- ✓ Logging Competitions
- ✓ Logging Nutrition
- ✓ Using your calendar, navigating & planning
- ✓ Accessing Reports
- ✓ Accessing Coaches Corner, Lounge and Messages
- ✓ Support



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**metrifit**  
linking practice to performance

# Logging On

The following is the link to use to logon to the system

<https://lusport.metrifit.com>

This will bring up a logon screen. Click on username and enter your username – this will usually be firstname.lastname

Click on password and enter your password. The default password is set to hst You will be asked to change your password when you logon initially.

To use the mobile version you don't download an app – you initially use your mobile browser and save as icon to your home screen or bookmark. The URL for the mobile is <https://lusport.metrifit.com/m>

Full manuals on Coaches corner for main system and the mobile version with common issues and set up descriptions

# Internet Browsers

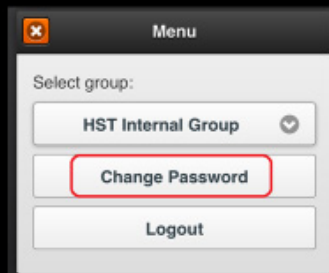
Recommend that you use Google Chrome

If using Internet Explorer please ensure you are using at least IE 9

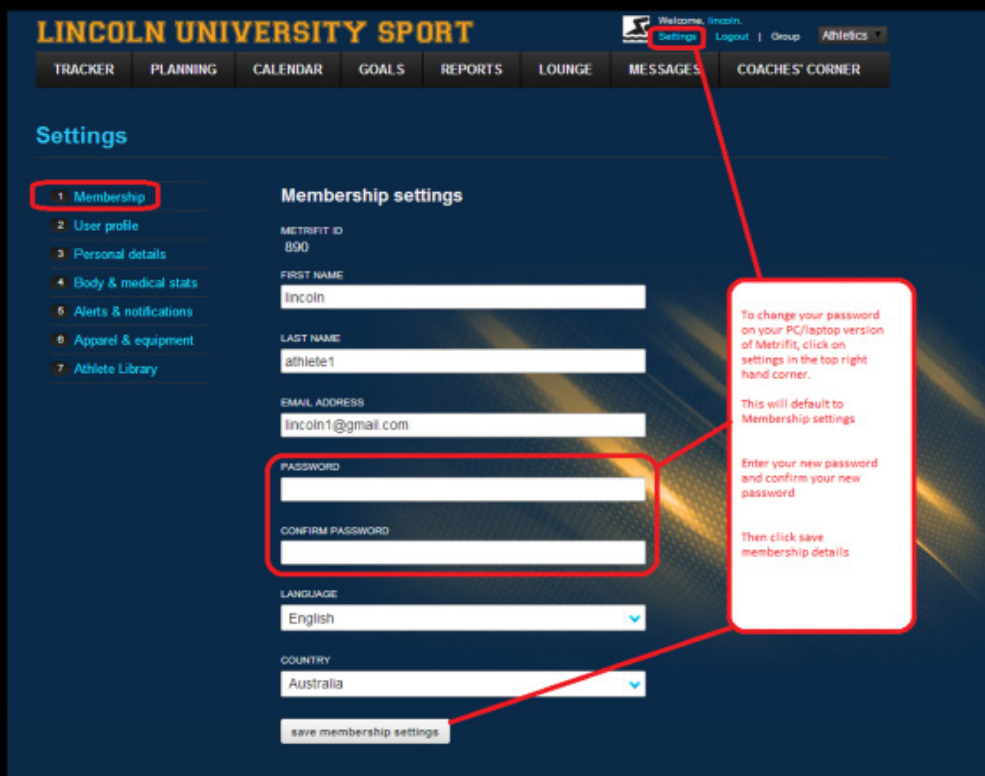
You can check your browser version by accessing the following URL

[www.whatbrowseramiusing.com](http://www.whatbrowseramiusing.com)

## Security – Changing your Password – Mobile Version



## Security – Changing your Password – PC/Tablet Version



# Settings

## Membership Settings

Membership settings allows you to change your password and you can also set your preferences here by entering language and country which affect the date and time formats on the system.

## User Profile

Here you can upload your avatar and action photos. Your avatar is the picture that you see in top right hand corner and the picture that other users in your groups will see in the LOUNGE area. Your action photos will be showed on your home/TRACKER page.

## Personal Details

Please ensure that you have your correct email on the system so that you can be contacted by email and when entering phone numbers please include +64 country code. Enter these and details and scroll down and click on 'Save Profile Settings'

## Body & Medical Stats

Enter medical information here

## Alerts & Notifications

In this area you can select any notifications for certain events that you want to receive.

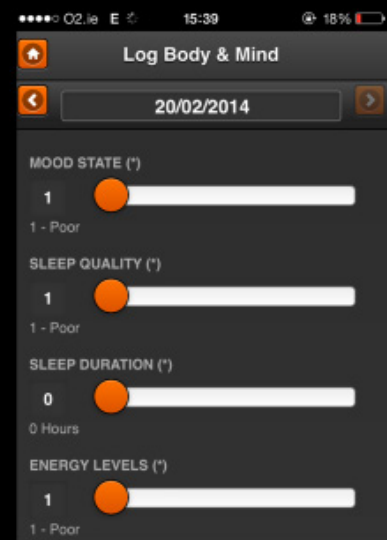
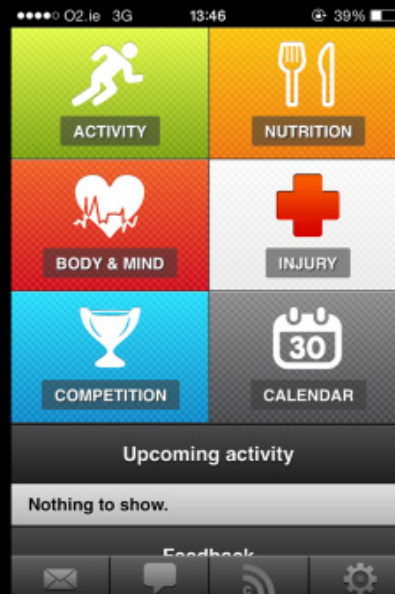
# Body & Mind

- ✓ Expected to log this every day
- ✓ Best time to do this is before you get up in the morning
- ✓ It's a useful exercise to record your Resting Heart Rate but this is not compulsory
- ✓ Use mobile version for ease of use
- ✓ The readiness to train calculation helps to determine periods of time when you might not be fully ready to train and need some rest time.
- ✓ Staff/Coaches will receive daily reports



## Body & Mind

- ✓ Use the mobile version for ease of use for logging.
- ✓ Try to be as honest as possible and use the descriptors to help you choose



## Body & Mind

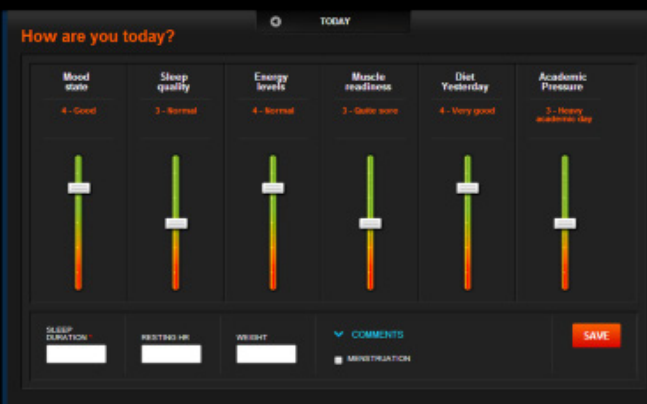
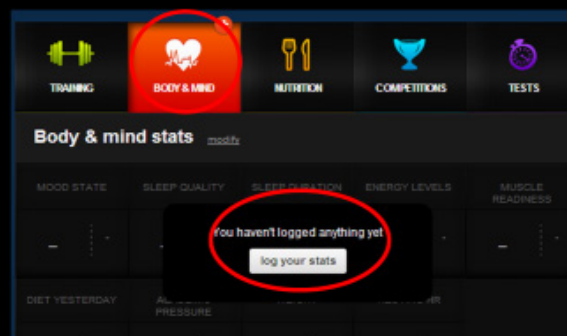
The non-slider information is optional

### Weight

It is recommended that you log your weight once a week; preferably at the same time i.e. Monday 9am

### Resting Heart Rate

Resting Heart Rate can be a really good indicator of general health and is very useful to take on a daily basis. There are lots of applications for SMART phones that measure this for you using your phone camera flash but you can learn how to do it yourself. For more information have a look at the following weblink <http://www.1yvaor.com/article/resting-heart-rate-health-measurement/>





## Logging Injury

**Body & mind stats**

MOOD STATE SLEEP QUALITY SLEEP DURATION ENERGY LEVELS MUSCLE SORENESS

You haven't logged anything yet

log your stats

Comments

Injuries & illnesses

report an injury or illness

### Log your injury

#### Report an injury / illness

INJURY LOCATION: Arm

INJURY TYPE: Impact

INJURY TISSUE TYPE: Muscle

INJURY SEVERITY: Moderate - had to adjust training

REPORTED TO:

START DATE OF REHAB: 26/02/2014

LAST DAY OF INJURY (EXPECTED):

LAST DAY OF INJURY (ACTUAL):

INJURY INFORMATION

RESPONSE TO INJURY: Initially continued but then withdrew

HOW DID INJURY OCCUR: Match/competition

INJURY MECHANISM: Contact

INJURY SURFACE: Grass

PITCH CONDITION: Good

ADDITIONAL INFORMATION:

DIAGNOSIS

TREATMENT AND REHABILITATION

FUNCTION

ADD FILES

LOG A INJURY

When logging an injury estimate your recovery date by entering Last day of injury expected/

To close off an injury you need to modify your injury and enter the last day or injury/recovery date.

The Medical Staff at the University will look after injury modifications



## Modifying Injury

TRACKER PLANNING **CALENDAR** GOALS REPORTS LOUNGE MESSAGES COACHES' CORNER

Calendar

Practice Match Tests Goals Injuries Lifestyle

Today February 2014

Mon	Tue	Wed	Thu	Fri	Sat	Sun
27	06:30 AD Session	28	06:30 AD Session	29	15:30 v Some team	30
3	4	5	6	11:30 AD Session	15:30 v Kerry	8
10	10:25 P5	11	15:08 v test	12	13:00 v Test	14
	15:30 SAS		12:32 Training Camp		16:02 Recovery	
17	18	19	19:15 v Dr Cook	20	19:00 P	21
24	25	26	27	28	29	30

Arm

modify

delete

view tracker

day view

plan a practice

plan a match

plan a test

plan a lifestyle

Go to Calendar and click on the injury shown in red and select modify to modify your injury.

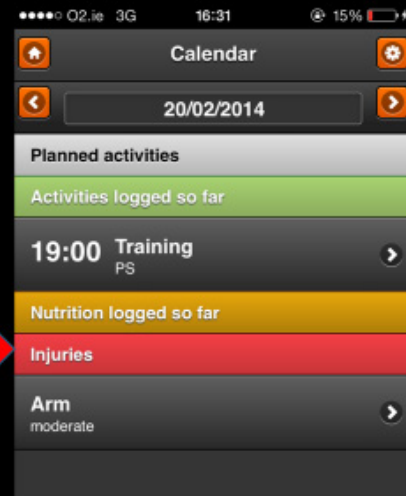
You can also see this on your TRACKER in Body & Mind

## Logging & Modifying Injury on the mobile

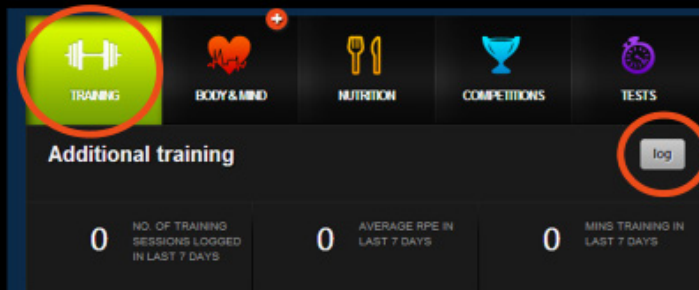


Clicking the Injury area on dashboard on the phone creates a new injury.

If you want to modify an existing injury or set the recovery date to close off the injury on the mobile version select Calendar and then click on the logged injury



## Logging Training

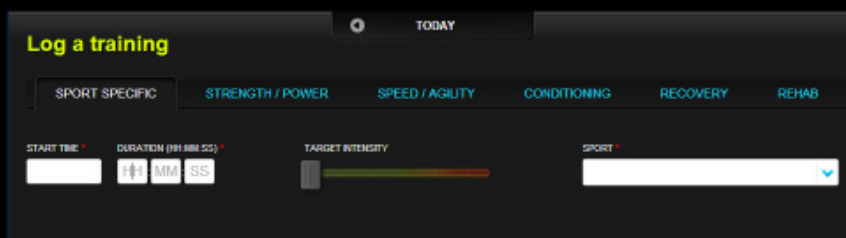


On the PC version to TRACKER and select TRAINING

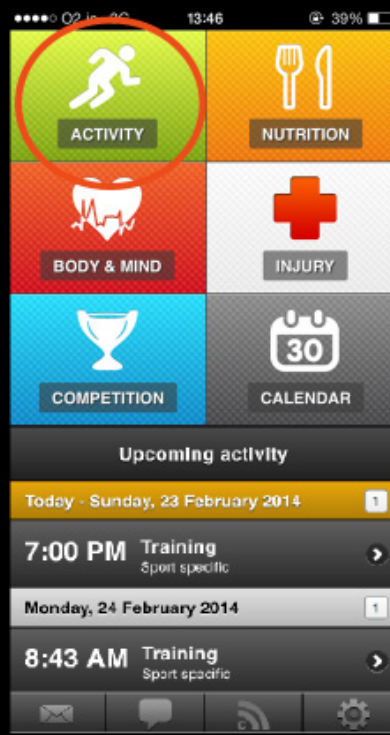
If you have any planned training it will show up here already.

If you want to log from scratch select log

This will bring you into training form where you need to select the type of training



## Logging Training - Mobile



On the mobile version select **ACTIVITY**

This will allow you to log a training from scratch

This will bring you into training form where you need to select the type of training

If you have any planned training it will show up here already and you just need to click it to log it

## Logging Training Sessions

There are a number of different training types. These are explained below:-

Sport Specific	Strength & Power	Speed & Agility	Conditioning	Recovery	Rehab
<ul style="list-style-type: none"> <li>This training type is used for recording activities that you do specific to your main sport. It should detail technical coaching and team coaching sessions if applicable.</li> </ul>	<ul style="list-style-type: none"> <li>This training type should cover all the gym sessions that you do</li> </ul>	<ul style="list-style-type: none"> <li>This training type should cover all speed and agility sessions that you do</li> </ul>	<ul style="list-style-type: none"> <li>This training type should cover all the conditioning sessions that you do</li> </ul>	<ul style="list-style-type: none"> <li>This training type should cover all the recovery sessions that you do</li> </ul>	<ul style="list-style-type: none"> <li>Rehab Training is a training type that is used to log any rehab sessions or treatment sessions you do that are associated with an injury you have logged on the system.</li> <li>This training type should cover all the gym sessions that you do</li> <li>Medical Staff will usually be responsible for planning these for you</li> </ul>

## Logging Training Sessions – Key variables

There are a number of different training types. These are explained below:-

### Start Time

This is the start time of the session. If this is displaying in 24 hour format, you need to set your country to New Zealand in Settings and this will then display in am/pm

### Duration

This is the duration of the session. This should reflect the amount of time you were active.

### Target Intensity

This is the target intensity of the session i.e. how hard you expected/planned it to be.

### RPE - Rate of Perceived Exertion

Your rate of perceived exertion is an indication of how hard you worked during the session. You should complete this after cooldown/shower but no later than 1 hour post training/competition. Check out weblinks below to find out more information

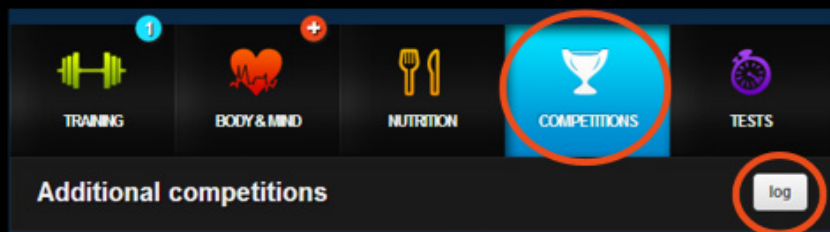
<http://www.brianmac.co.uk/borgscale.htm>

<http://www.livestrong.com/article/543824-what-is-the-rpe-scale-in-exercise/>

### How Did I do?

This is a personal rating of how you did regardless of the intensity of the session

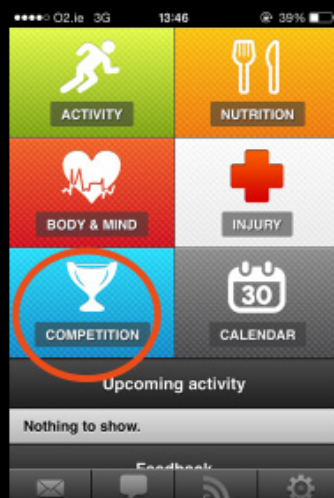
## Logging Competitions/Matches



On the PC version to  
to TRACKER and  
select  
COMPETITIONS

If you have any  
planned  
competitions it will  
show up here  
already.

If you want to log  
from scratch select  
log



## Logging Competitions – Key variables

### Event Duration

The reason you have competition duration and event duration is to cater for multi-event competitions (e.g. triathlons, swim meets). Also in team competitions you may have a match of 90mins duration but you may only have been active for 20 minutes. So use the Event Duration in the Performance area to log actual activity

### Performance

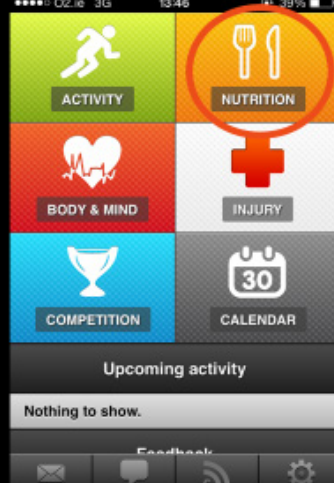
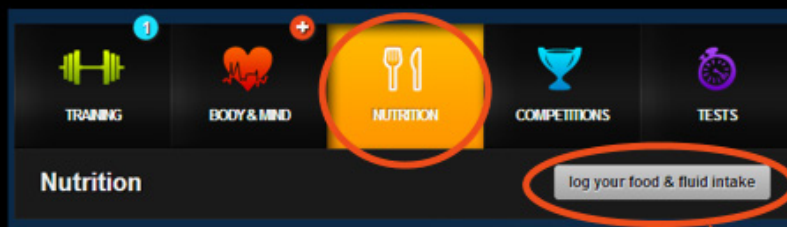
The performance section is generic to cover different sports so just fill out what is valid for you. Any compulsory variables are marked with an asterisk.

### Performance Analysis

The performance analysis section is really good for analysing your competition performance. You can specify what worked and what to improve in 4 different areas i.e.

- ✓ Physical
- ✓ Technical
- ✓ Tactical
- ✓ Psychological

## Logging Nutrition



On the PC version to  
to TRACKER and  
select NUTRITION

On the mobile  
version select  
Nutrition from the  
dashboard



## Planning your Calendar

To reduce amount of time taken to log through Metrifit it is advisable to spend some time each week planning your events.

You can do this through your Calendar by planning ahead.

You also have a detailed Planning section where you can build up a library of training sessions and assign to yourself as required

The User Manual on the Coaches Corner has step by step details of how to plan through the PLANNING area

NOTE: You cannot plan events on the mobile version



## Planning your Calendar

The screenshot shows the Metrifit web application interface. At the top is a navigation bar with tabs: TRACKER, PLANNING, CALENDAR, GOALS, REPORTS, LOUNGE, MESSAGES (with a notification badge), and COACHES' CORNER. Below the navigation bar is a 'Calendar' section with a sub-header 'February 2014'. There are buttons for 'Practice', 'Match', 'Tests', 'Goals', 'Injuries', and 'Lifestyle'. The calendar grid shows dates from 27 to 2. Various events are planned, such as 'Cervical spine' on Mon 27, '06:30 AD Session' on Tue 28, '06:30 AD Session' on Thu 30, '11:28 AD Session' on Fri 31, '15:30 v Kerry' on Sat 1, '18:25 PS' on Mon 10, '15:00 v Test' on Tue 11, '12:32 Training Camp' on Wed 12, '13:00 v Test' on Thu 13, '10:30 v Test' on Fri 14, '19:00 PS' on Sat 19, and '19:00 PS' on Sun 20. A context menu is open over the 20th, showing options: 'view tracker', 'day view', 'plan a practice', 'plan a match', 'plan a test', and 'plan a lifestyle'. An orange callout box on the right contains the text: 'To plan from your calendar, go to the CALENDAR and click on a date in the future. Here you can plan in advance. Planned training will show up on your mobile and you only have to enter RPE and How Did I do? as soon as possible after training/match occurs'.

## Accessing Reports

TRACKER PLANNING CALENDAR GOALS **REPORTS** LOUNGE MESSAGES COACHES' CORNER

### Reports

Body & Mind report from: 17/02/2014 to: 20/02/2014

Click on the dropdown box under Reports heading to toggle between the different reports

generate

export to PDF export to CSV

Line Bar



To access your REPORTS go to REPORTS on the non mobile version

Select the report you require.

Click on the date to change from or to date and click generate to view results

You can export all reports to PDF or to CSV which allows you to import into Excel

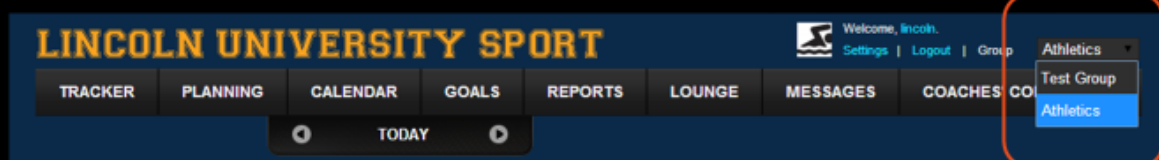
## Changing Groups/Lounge and Coaches Corner

You may belong to 1 or more groups on Metrifit

The only difference this will make to you is in the LOUNGE and Coaches Corner areas. Each group has its own versions of these

### Changing groups – PC/Laptop Version

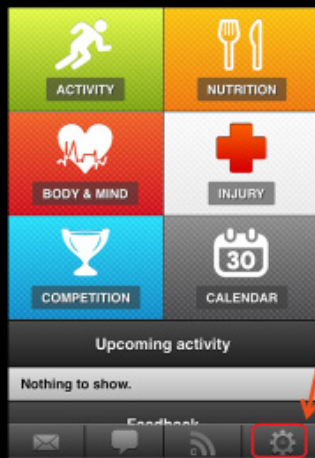
Click on the dropdown box to the right of Group near top right hand corner of your screen.



**NOTE:** This ONLY changes your view of LOUNGE and COACHES CORNER. All other areas are accessed the same way.

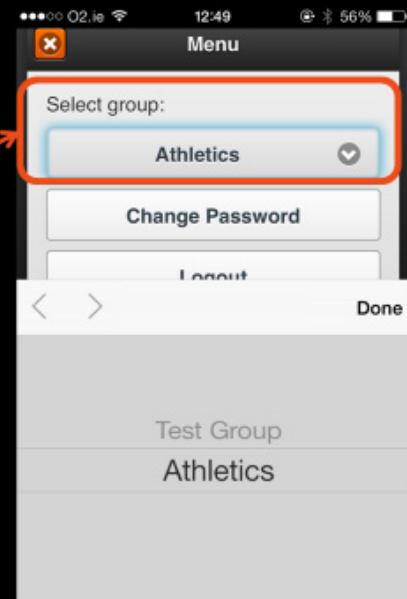
## Changing Groups/Lounge and Coaches Corner

### Changing groups – Mobile Version

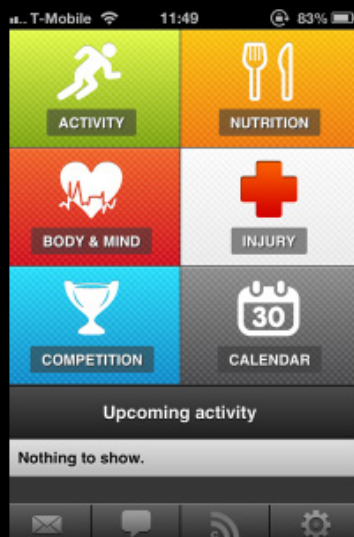


Click on settings on the mobile version

Then in drop down box under Select group change your group



## Accessing Coaches Corner, Lounge & Messages



This is the messages icon and it will bring you into the messages area of the system to send and receive individual messages to users and coaches/staff in your group



This is the lounge icon. This allows you to read and post messages on the lounge for your group. If you belong to more than one group you can change groups through the settings area



This is the icon for Coaches Corner. Here you can view items and filter by tags etc for the Coaches Corner



This is the settings icon. Here you can change groups to view other lounge and coaches corner information. You can also logout/



## Loading files to your Library (non-mobile version)

**Lincoln University Sport**

Welcome, Lincoln. [Settings](#) | [Logout](#) | [Group](#) | [Test Group](#)

**TRACKER** | **PLANNING** | **CALENDAR** | **GOALS** | **REPORTS** | **LOUNGE** | **MESSAGES** | **COACHES' CORNER**

### Settings

- 1 Membership
- 2 User profile
- 3 Personal details
- 4 Body & medical stats
- 5 Alerts & notifications
- 6 Apparel & equipment
- 7 Athlete Library**

### Athlete Library

#### Add a new document

[add photos](#) | [add files](#) | [add video](#)

**FILTER BY TYPE** | **FILTER BY CATEGORY**

Choose a type | Choose a category

TITLE	DESCRIPTION	CATEGORY	CREATOR
Athlete upload <a href="#">edit</a>   <a href="#">remove</a>	desc	Review	lincoln athlete1
Coach upload	test	Personal	Metrifit Team

[load more](#)

**To load documents to your library:**

Go to Settings, Go to Athlete Library

Here you can view files that have been uploaded by staff for you but you can also add a new document yourself.

**Lincoln University**  
Te Whare Wānanga o Aotearoa  
Christchurch New Zealand  
New Zealand's specialist land-based university

## Support

There is a support button on left hand side of PC version which you can use to contact our helpdesk.

Alternatively email us at [support@metrifit.com](mailto:support@metrifit.com)

Please ensure that you have the mobile version working to help with the logging process.

There are full user guides and a mobile guide on the Coaches Corner